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An Annotated Bibliography of the Chinch Bug

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Abstract

S. Ramnath, J.F. Pedersen, and J.E. Foster, eds. 1995. An Annotated Bibliography of the Chinch Bug. U.S. Department of Agriculture, Agricultural Research Service, Bibliographies and Literature of Agriculture Number 130, 94 pp.

The chinch bugs of the genus *Blissus* are important pests of crops belonging to the family Graminae. The common chinch bug [*Blissus leucopterus leucopterus* (Say)] is a major pest of maize and sorghum. The southern chinch bug (*Blissus insularis* Barber) and the hairy chinch bug (*Blissus leucopterus hirtus* Montandon) are pests of turfgrasses. The economic importance of the genus *Blissus* and the lack of progress in controlling the chinch bug merit review of all information derived from observations and research since the first report of this pest. Researchers addressing chinch-bug-related problems have difficulty locating the pertinent literature because much of it is dated and is published in obscure sources. This annotated bibliography summarizes each publication and identifies key publications in the literature. The target audience for this publication is scientists and extension personnel who work with chinch bugs and the problems they cause.

Keywords: *Blissus leucopterus leucopterus*, *hirtus*, *insularis*, biology, insecticides, plant resistance.

 While supplies last, copies of this publication may be obtained free of charge from Dr. Jeffrey F. Pedersen, USDA-ARS Wheat, Sorghum, and Forage Research, University of Nebraska, 329 Keim Hall, Lincoln, NE 68583-0937.

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An Annotated Bibliography of the Chinch Bug

The chinch bugs of the genus *Blissus* are important pests of crops belonging to the family Gramineae. The common chinch bug [*Blissus leucopterus leucopterus* (Say)] is a major pest of maize and sorghum. The southern chinch bug (*Blissus insularis* Barber) and the hairy chinch bug (*Blissus leucopterus hirtus* Montandon) are pests of turfgrasses. The economic importance of the genus *Blissus* and the lack of progress in controlling the chinch bugs merit a review of all information derived from observations and research since the first report of this pest. Researchers addressing chinch-bug-related problems have difficulty locating the pertinent literature because much of it is dated and is published in obscure sources. This annotated bibliography summarizes each publication and identifies key publications in the literature. The target audience for this publication is scientists and extension personnel who work with chinch bugs and the problems they cause.

Ahmad, T.R. 1981. Comparative biology and economics of the chinch bug *Blissus leucopterus leucopterus* (Say) on wild and cultivated grasses. University of Nebraska, Lincoln. Ph.D. thesis.

Studies were conducted on the comparative tolerance of several sorghum varieties and other grasses to chinch bug *Blissus leucopterus leucopterus* (Say) feeding. Field studies were undertaken to determine the distribution of overwintering bugs and to develop degree-day models to predict the seasonal history of this pest. Fecundity and longevity were found to be influenced by the variety or species of the host plant. Corn was the preferred host in ovipositional studies.

Rate of development of nymphs was significantly slower on oats and Early Sumac sorghum than on DeKalb DK-61 sorghum, wheat, barley, corn SX-19, and ACCO GR-1089 sorghum. Use of degree days for predicting the peak of each ontogenetic stage of the first generation was more accurate than calendar dates, demonstrating that temperature is not the only factor that can be used for predicting the seasonal history of the pest. Different grass species showed different degrees of injury by nymphs. Studies indicated that more overwintering bugs were found in *Schizachyrium scoparium* and *Sorgastrum nutans* than in *Panicum virgatum* and *Bromus inermis*.

Ahmad, T.R., S.D. Kindler, and K.P. Pruess. 1984. Recovery of two sorghum varieties from sublethal infestations of chinch bug *Blissus leucopterus leucopterus* (Say) (Hemiptera: Lygaeidae). Journal of Economic Entomology 77:142-150.

Effects were investigated for different levels of chinch bug infestation during the seedling stage of sorghum on subsequent plant growth and yield after bug removal. Sorghum cultivars Early Sumac and DeKalb DK-61 were subjected to different levels of chinch bug infestation during the seedling stage. Seedlings were initially stunted for a week as a result of chinch bug feeding. At infestation levels of 5 and 10 bugs per plant, Early Sumac incurred 28 percent and 61 percent plant mortality, respectively. Final yields from surviving plants transplanted to the field did not differ significantly from controls. Grain yields from DeKalb DK-61 were reduced 28 percent and 68 percent, respectively, at identical infestation levels even though all plants survived and visually recovered from chinch bug damage after field transplantation.

Ahmad, T.R., K.P. Pruess, and S.D. Kindler. 1984. Non-crop grasses as hosts for the chinch bug *Blissus leucopterus leucopterus* (Say) (Hemiptera: Lygaeidae). Journal of Kansas Entomological Society 57:17-20.

Suitability of several grass species as potential hosts for the chinch bug *Blissus leucopterus leucopterus* (Say) was studied. Twelve grasses were tested, with yellow foxtail and goosegrass being tolerant hosts and giant foxtail being susceptible. Indiangrass (tolerant) and switchgrass (susceptible) served as hosts in the greenhouse but were not observed to be eaten by nymphs in the field. Fall panicum, big bluestem, Kentucky bluegrass, bermudagrass, and St. Augustine grass exhibited apparent antibiosis.

Ali, A.D., and M.A. Harivandi. 1987. Chinch bugs in lawns. University of California Cooperative Extension Service Leaflet (21438):2.

This is a brief report about the occurrence of *Blissus insularis* Barber in lawns in California.

Andre, F. 1937. An undescribed chinch bug from Iowa. Iowa State College Journal of Science 11:165-167.

This is the first report on the identification of a new species of chinch bug in Iowa. Chinch bugs were collected from little bluestem as part of a hibernation study in the winter 1935. The samples contained numerous specimens of the common chinch bug *Blissus leucopterus*.

The sample also contained another species that was quite distinct from *B. leucopterus* and *B. occiduus*. This new species was described and named *B. iowensis* by Andre. This insect is smaller than the common chinch bug, has a flatter pronotum, and has a relatively long rostrum. *B. iowensis* is more closely related to *B. occiduus* than any other chinch bug species. *B. iowensis* fed only on little bluestem and was not observed on any cultivated crop under field conditions.

Annand, P.A. 1935. The chinch bug problem-present situation and probabilities for 1935. Proceedings of the North Central Branch of the Entomological Society of America 14:13-14.

An attempt was made to obtain a cooperative survey of all the chinch-bug-infested states in order to prepare for the ensuing crop season. Overwintering areas were sampled and a population of 15 bugs/ft^2 was considered dangerous (where damage might occur). The survey was combined across the United States, and infestation was classified as light, moderate, or heavy. Uniform interpretation of the data across all states was difficult because of varying regional conditions. A heavy infestation level in Ohio only appeared to be a moderate or light infestation under Iowa conditions. The need to develop adequate survey methods for future use is emphasized.

Baker, P.B., and R.H. Ratcliffe. 1977. Evaluation of bluegrasses for tolerance to *Blissus leucopterus hirtus* (Hemiptera: Lygaeidae). Journal of the New York Entomological Society 85:165-166.

Cultivars of Kentucky bluegrass (*Poa pratensis* L.) were evaluated in the laboratory for tolerance to the hairy chinch bug. It was found that infestation levels of two or more adults per plant severely injured the plants. Root and top growth were significantly reduced. There were also considerable differences in regrowth, yield, percent dry matter, and plant survival among cultivars, indicating these factors may be useful criteria for measuring tolerance.

Baker, P.B., R.H. Ratcliffe, and A.L. Steinhauer. 1981. Laboratory rearing of the hairy chinch bug *Blissus leucopterus hirtus*. Environmental Entomology 10:226-229.

This paper describes laboratory procedures to rear the hairy chinch bug on corn sections. The authors suggest that eggs be sterilized in 2 percent sodium hypochlorite solution to enhance survival of nymphs and adults. Adult survival was significantly higher when chinch bugs were reared on corn sections treated with the solution.

Baker, P.B., R.H. Ratcliffe, and A.L. Steinhauer. 1981. Tolerance to hairy chinch bug *Blissus leucopterus hirtus* feeding in Kentucky bluegrass (*Poa pratensis*). Environmental Entomology 10:153-157.

In this important paper 17 Kentucky bluegrass cultivars were evaluated for tolerance to feeding by adult hairy chinch bugs. Regrowth, yield of clippings, root length, and plant survival significantly decreased and the percentage of dry matter significantly increased as a result of adult feeding in almost all the cases. The greatest significant difference because of feeding was observed in dry weight, root weight, and tillering.

Barber, H.G. 1918. A new species of *Leptoglossus*: a new *Blissus* and varieties. Bulletin of the Brooklyn Entomological Society 13:35-39.

This reference describes in taxonomic terms *Leptoglossus brevirostris* and three varieties of *Blissus leucopterus, namely, hirtus, arenarius,* and *insularis.*

Bauernfeind, R.J. 1987. Residual effectiveness of insecticides for the control of chinch bugs (Heteroptera: Lygaeidae) in sorghum. Journal of the Kansas Entomological Society 60:336-339.

The author conducted field trials to determine the actual residual effectiveness of various insecticides (carbaryl, carbofuran, fenvalerate, parathion, endrin, and chlorpyrifos) against the chinch bug *Blissus leucopterus leucopterus* (Say). A Solo 425 knapsack sprayer equipped with a TeeJet even-fan nozzle was used to apply 280 L/ha of all the insecticides to a 30.5-m row of sorghum. All chemicals provided an acceptable kill rate (at least 90 percent reduction in population) within the first day of application. Only carbaryl and carbofuran continued to suppress chinch bugs for 48 hr. The average time for reductions to 80 percent and 50 percent effectiveness were 66.0 and 70.5 hr, respectively, for carbaryl and 59.2 and 70.4 hr, respectively, for carbofuran.

Benton, C., and W.P. Flint. 1938. The comparative attractiveness of various small grains to the chinch bug. U.S. Department of Agriculture, Agricultural Research Service Circular 508, 7 pp.

One of the most common management practices suggested for control of the chinch bug *Blissus leucopterus leucopterus* (Say) is to refrain from extensive cultivation of small grains and to use them as trap crops instead. This study was conducted to ascertain the effec-

tiveness of this recommendation. Observations were made in small grain fields in northern Illinois in 1934, 1935, and 1936 and in west-central Illinois in 1937. The researchers found that no small grain was sufficiently more attractive than the others for use as a trap crop. They also found that the crop preferences of the chinch bugs migrating from overwintering quarters varied with the weather and the growth of the small grains. In 1934, rye and winter wheat were the crops preferred, whereas, in 1935 and 1936 spring barley was preferred. Oats were least attractive throughout the study.

Bigger, J.H. 1935. Cropping practices as they relate to chinch bug abundance and control. Proceedings of the North Central Branch of the Entomological Society of America 14:16-17.

This article is intended to inform Illinois farmers about prevention and avoidance tactics for chinch bug management, rather than the use of control measures after infestation has occurred. A six-point program is suggested for (1) reduction of chinch bug breeding grounds; (2) increased use of nonfood crops; (3) separation from breeding grounds of normal fields where food crops are grown; (4) interplanting of legumes; (5) use of resistant or tolerant varieties of food crops; and (6) use of emergency barriers as a last resort.

Bigger, J.H. 1935. Third brood chinch bugs observed in Illinois for the first time. Journal of Economic Entomology 28:27.

The common chinch bug usually has only two broods every year. A partial third generation has been reported from some parts of the country. This paper describes the occurrence of a third brood of the pest in Illinois for the first time.

Bigger, J.H., and H.B. Petty. 1953. New control for chinch bugs. Illinois Agricultural Experiment Station Circular 707, 4 pp.

This circular is written entirely in a question-and-answer format. The authors warn farmers to be ready for a massive chinch bug *Blissus leucopterus leucopterus* (Say) infestation in 1953. The author suggests growing stands of legumes in thick, sturdy stands of small grains to deprive the chinch bugs of favorable sites. The newest method of control, as described in the circular, is the use of dieldrin, a then new insecticide, sprayed on barrier strips before the bugs move into corn. Parathion, lindane, aldrin, and chlordane are also recommended for use.

Billings, F.H. 1911. Results of the artificial use of the white fungus diseases in Kansas: with notes on approved methods of fighting chinch bugs. U.S. Department of Agriculture, Bureau of Entomology, 123 pp.

Sporotrichium globuliferum is a fungus that affects control of the chinch bug *Blissus leucopterus* leucopterus (Say). Experiments have been done with this fungus in Nebraska and Kansas within the past few years. An outline of the work done with the fungus in Kansas in 1910 is presented. In Kansas, infected bugs were collected from the field and brought back to the laboratories where healthy bugs were released into cages with the infected bugs. The newly infected bugs were then given to applicants. The literature on chinch bug control using this fungus is reviewed in detail.

Britcher, H.W. 1903. The chinch bug in Maine. Bulletin of the Maine Agricultural Experiment Station 91:42-52.

The chinch bug *Blissus leucopterus* (Say) has been reported in all states in the union except Oregon, Washington, Montana, Idaho, Nevada, Utah, and Arizona. This bulletin reviews the history of the chinch bug in Maine and describes the insect's life history in this State. The Maine Agricultural Station, in its 1892 report, stated that chinch bugs have been found in Maine since the late 1860's. The bug caused extensive damage to grass crops in 1892. Remedies suggested are (1) burning rubbish, such as dried grass, weeds, brush heaps, and sedge grasses; (2) spraying of kerosene emulsion; and (3) plowing a strip of crop where many chinch bugs are taking shelter. The author did a series of 25 experiments and concluded the following: (1) chinch bug hibernation was not a period of continuous torpidity (bugs removed from overwintering sites and exposed to warm conditions became active); (2) the bugs did not die after a prolonged period of submersion in water but did die when frozen under the same conditions; and (3) when bugs were exposed to an atmosphere with low humidity, freezing proved fatal.

Bruner, L., and H.G. Barber. 1894. Experiments with infectious diseases for combating the chinch bug. Bulletin of the Nebraska Agricultural Experiment Station 34:143-161.

This issue describes one of the first reported experiments with pathogens for control of the common chinch bug. A supply of chinch bugs killed by the fungus *Sporotrichium globuliferum* was secured and

supplied in sufficient quantities to all applicants for field inoculation. Directions for obtaining and applying the fungus are given. A brief description of chinch bug diseases (for example, white-fungus disease, bacterial disease, and gray-fungus disease) and a note on bogus-chinch bugs are also presented.

Bruton, B.D., J.A. Reinert, and R.W. Toler. 1979. Effects of the southern chinch bug (*Blissus insularis*) and the St. Augustine decline strain of panicum mosaic on seventeen accessions and two cultivars of St. Augustine grass. Phytopathology 69:1-A1, S6.

St. Augustine grass accessions and varieties were evaluated for resistance to the southern chinch bug and to the decline strain of Panicum mosaic virus, and for combined resistance to both under laboratory conditions. Mortality of adult bugs after 4 days of feeding on cultivars ranged from 8.3 percent in Florida Common to 61.7 percent in Floratam. Over a 5-mo period in the field, chinch bug populations on the two cultivars ranged from 12.9 adults/ft^2 in Florida Common to 0.3/ft^2 on Floratam. Reaction to airgun inoculation of the virus was tested. After two inoculations, damage levels ranged from 1 (no symptoms) to 3.8 (severe mottling). Ten of the 17 accessions failed to develop symptoms. Florida accessions such as FA-108, FA-118, FA-46, FA-243, FA-121, FA-64, and FA-82 exhibited combined resistance equal to or approaching that of Floratam.

Bruton, B.D., R.W. Toler, and J.A. Reinert. 1983. Combined resistance in St. Augustine grass to the southern chinch bug and the St. Augustine decline strain of panicum mosaic virus. Plant Disease 67:171-172.

St. Augustine grass accessions resistant to the southern chinch bug were screened for resistance to the St. Augustine decline strain of the Panicum mosaic virus (PMV-SAD). Seventeen accessions and two cultivars were used in this greenhouse experiment. A bioassay on German strain R millet showed that FA-38, FA-82, FA-217, and FA-236 were symptomless carriers of the virus. Combined resistance to the chinch bug and the virus was exhibited by FA-46, FA-64, FA-121, FA-243, FA-108, and FA-118, the last two accessions being comparable to Floratam in terms of combined resistance. The authors tested the relationship between pigments of stolons or stigmas to resistance and found no correlation.

Bryson, H.R. 1928. Hibernation of chinch bugs in Sudan grass. Journal of Economic Entomology 21:857-862.

A study was conducted to demonstrate the effectiveness of sudangrass (*Sorghum vulgare sudanensis*) as hibernating quarters for the common chinch bug. The period of study was from 1917 to 1927. Chinch bug counts were taken at monthly intervals in winter. Six hundred and four bunches were examined from various fields in Kansas, and a maximum of 540 bugs per bunch was found, with an average of 21.1 live bugs per bunch. Sudangrass was not as suitable as the native bunchgrasses for hibernation, but this study proved that sudangrass can also be an overwintering host. Bunches that were uncut and tall and those which had a thick canopy served as the most suitable overwintering quarters for the bugs.

Bunsen, G.C. 1888. A proposed remedy for the chinch bug. Insect Life 1:218-220.

The author proposes a novel remedy for the common chinch bug. Huge numbers of chinch bugs started moving into Indian corn and Texas sugarcane from rye. Dusts, coal oil, and other insecticides failed to control the bugs. Convinced the bugs could not be killed by poison, the writer decided to kill them with hot water. Hot water poured on the lower parts of plants infested with the bugs killed the bugs outright. The plants were not hurt. The hot water treatment was eventually replaced by steam, which also produced very good results. Steam treatment also exterminated armyworms, grasshoppers, and cabbage worms.

Burkhardt, C.C. 1958. Control of insects attacking sorghum. Proceedings of the North Central Branch of the Entomological Society of America 13:20-22.

A brief account on the control of major pests of sorghum, such as the corn leaf aphid, corn earworm, fall armyworm, chinch bug, and the Kafir ant is presented in this paper. Results are discussed from tests with Thimet seed treatment for protection of sorghum seedlings from chinch bug injury. Seed treatments of 2, 4, and 8 lb of granular Thimet/100 lb of seed were not successful in preventing the destruction of plants. When plots were provided with an additional 0.5, 1, and 2 lb of Thimet, a significant difference was found in the appearance of treated and untreated plots after 3 days.

Burkhardt, C.C. 1959. Increasing sorghum stands in field tests by controlling thief ant and other insect pests. Journal of Economic Entomology 52:365-368.

Field studies on increasing sorghum stands by controlling insect pests were conducted in Kansas from 1956 through 1958. The effect of seed and soil treatment of insecticides was tested. Seeds of both grain and forage-type sorghum were treated with dieldrin, heptachlor, and lindane during the 3 yr of evaluation. This resulted in stand increases ranging from 2 percent to 571 percent during the study period. Thief ants and seed-corn beetles did most of the damage in the field. Insecticides used for seed treatment were also used in the soil treatment studies. The insecticides were broadcast and disked in immediately since such treatment gave complete control of chinch bugs. Soil treated with 2 lb aldrin or heptachlor or 1.5 lb of dieldrin resulted in excellent stands and higher yields than seed treatment did.

Burks, B.D. 1934. Food plant studies of the chinch bug. Journal of Economic Entomology 28:1100-1101.

This is a scientific note on a study conducted with bermudagrass, timothy grass, Kentucky bluegrass, corn, meadow foxtailgrass, chinch-bug-resistant sorghum, reed canarygrass, Hungarian millet, wild barley, quackgrass, Washington creeping bentgrass, little bluestem, and sudangrass to determine the preferred host plants of the chinch bug *Blissus leucopterus leucopterus* (Say). The study found that the median time for the bugs to develop on these plants varied from 33 to 37 days. Of the bugs reared on the grass plants, 17 percent died. None of the plants died during the time the chinch bugs were feeding on them.

Burlison, W.L., and W.P. Flint. 1923. Fight the chinch bug with crops. Illinois Agricultural Experiment Station Circular 268, 15 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) has never been known to cause damage to any crop not belonging to the grass family. This circular briefly describes the methods of culture, rate of seeding, varieties, and other information concerning the growth of some of the important crops on which the chinch bug will not feed. The crops dealt with are soybeans, cowpeas, fodder beets, buckwheat, sunflowers, and rape. Also, the names of four chinch-bug-resistant corn varieties, namely, Champion White Pearl, Democrat, Black Hawk, and Golden Beauty, are provided.

Busey, P. 1990. Inheritance of host adaptation in the southern chinch bug (Heteroptera: Lygaeidae). Annals of the Entomological Society of America 83:563-567.

Crossing experiments involving PDP-1, PDP-2, and STD strains of the southern chinch bug were performed. Interpopulation crosses (for example, nonadapted × adapted) were intermediate in oviposition rate and longevity compared with parent populations. Reciprocal F_2 crosses of chinch bugs confined on Floratam were performed to study the inheritance of host adaptation. The experiments proved that different populations of southern chinch bugs can interbreed. When regional sources of adapted chinch bugs were intercrossed, the progenies were also well adapted to the resistant cultivars. The author proposed that host adaptation was controlled by the same genes or similar gene action in different sources.

Busey, P. 1990. Polyploid *Stenotaphrum* germplasm resistance to the polyploid damaging population of southern chinch bug. Crop Science 30:588-598.

A study was conducted to identify St. Augustine grass germplasm resistant to the polyploid-damaging population (PDP) of southern chinch bug *Blissus insularis*. Polyploid germplasm was previously considered to be resistant to the southern chinch bug, but PDP southern chinch bugs were able to adapt and injure Floratam within 12 yr of its release. Chinch bugs from four sources were used in the study: (1) PDP-1, a PDP lawn strain capable of damaging Floratam; (2) PDP-2, a strain of PDP (sod strain) that damages Floratam maintained in the laboratory; (3) PDP-3, a PDP sod strain recollected from the fields; and (4) a non-Floratam-damaging STD (standard) laboratory strain.

Four different bioassays were performed, and the parameters used to identify resistant clones were reduced chinch bug longevity, oviposition rate, and excreta production. Floratam was used as the reference cultivar. The most resistant clones were PI 365031, a pembagrass [*Stenotaphrum dimidiatum* (L.)], FX-2, FX-10, and FX-33 (intercrosses of polyploid *S. secundatum* from Africa). These accessions showed low PDP southern chinch bug oviposition rates (≤5 eggs/female/wk and ≤25 eggs/lifetime). FX-33 and FX-10 had characteristics typical of African polyploid St. Augustine grass germplasm.

Busey, P., and B.J. Center. 1987. Southern chinch bug (Hemiptera: Lygaeidae) overcomes resistance in St. Augustine grass. Journal of Economic Entomology 80:608-611.

Floratam, a St. Augustine grass polyploid cultivar, has been known to be resistant to the southern chinch bug for a long time. The breakdown of chinch bug resistance by a polyploid-damaging population (PDP) of the southern chinch bug is reported here. A local, standard (STD) population that was not damaging to Floratam was used for comparison. Resistant and susceptible St. Augustine grass cultivars were fed to both populations of chinch bugs. Nymphal development, adult longevity, and egg production of PDP were compared with the same parameters of the STD population. The STD population survived 12 and 22 days, respectively, on Floratam and Floralawn (resistant cultivars) but survived 77 days on Florida Common (a susceptible variety). The PDP survived an average of 62 days on Floratam and 80 days on Floralawn. PDP females laid an average of 30 eggs on Floratam and 85 eggs on Floralawn, whereas STD females laid an average of 2 eggs on resistant cultivars. Only PDP on resistant cultivars developed to adulthood.

Busey, P., and E.I. Zaenker. 1992. Resistance bioassay from southern chinch bug (Heteroptera: Lygaeidae) excreta. Journal of Economic Entomology 85:2032-2038.

The amount of excreta has been used as a marker to discover resistant germplasm in previous resistance screening tests, but the weight of excreta has not been used in resistance studies. The development of a feeding bioassay using the excretal residue of the southern chinch bug is reported in this paper. Young females on Florida Common, a suitable host, produced more excreta in dry weight than the males did. There were significant differences among different hosts in the dry weight of excreta of males but not of females.

Based on low excreta weight, Floratam was given the top rank, followed by FX-261, FX-305, and Florida Common. The ovipositional rate was much lower in polyploids previously known to be resistant. Mean oviposition on diploids was higher than that on the polyploids. The excreta dry weight and grass residency were reduced on Floratam compared with the susceptible FX-313 within 24 hr of presentation. The authors concluded that visual evaluation of the amount of excreta was a rapid and powerful tool for detecting resistance.

Carter, R.P., and R.L. Duble. 1976. Variety evaluations in St. Augustine grass *Stenotaphrum secundatum* for resistance to the southern lawn chinch bug *Blissus insularis.* Progress Report of the Texas Agricultural Experiment Station 3374C, 39 pp.

St. Augustine grass varieties were first screened for resistance to the St. Augustine decline virus. Then, 23 virus-resistant varieties were screened for southern chinch bug resistance. Chinch bugs were collected from fields and released in the center of each experimental plot with 50 adults per plot. Approximately 6 wk after infestation, the plants started showing symptoms of damage. The degree and rate of damage were used as indicators of tolerance levels among the selections. Damage ratings based on visual observations indicated that Floratam and Scotts SAV-5 were resistant to chinch bug damage. Selections such as 444, 143, and 362 showed more tolerance than the two Scotts varieties, 1081 and 6416, that were developed for chinch bug resistance. Selections 444 and 143 had significantly more bugs per plot than any other selections in the study. Coarseness of the selections seemed to be negatively correlated with damage.

Castro, A.G. De. 1981. Pastures exposed to new threats from Chinch bug (*Blissus leucopterus*). Agriculture Hoje 7(73):32-33.

Four hundred ha of pasture were highly damaged because of the appearance of the common chinch bug in 1980. The chinch bug was first seen in the city of Macae, Rio de Janeiro. There is a possibility that the pest will move into sugarcane, rice, and corn and damage these crops, thereby threatening the economy of the state of Rio de Janeiro (translated from Portuguese).

Chambliss, C.E. 1895. The chinch bug, *Blissus leucopterus* (Say). University of Tennessee Agricultural Experiment Station Bulletin 34:42-55.

Observations made on the chinch bug in Tennessee from 1874 to 1895 are given. The presence of this insect was noticed in 1868 in this State. The fact that wet weather is extremely disastrous to the pest, whereas dry weather is favorable, was re-established. The effect of temperature and rainfall on chinch bugs is presented in a table. The bulletin describes the history of the chinch bug in the United States and briefly comments on the pest's status in Tennessee. The life history of the pest in Tennessee is described in great detail; it is not different from that in other states. A section each on natural enemies of the chinch bug and preventive and remedial measures is also presented.

Choban, R.G., and A.P. Gupta. 1972. Meiosis and early embryology of *Blissus leucopterus hirtus* Montandon (Heteroptera: Lygaeidae). International Journal of Insect Morphology and Embryology 1:301-314.

This is perhaps the only paper published to date that deals with embryology and meiosis in the hairy chinch bug. Maturation is in progress even as the eggs are laid and is completed after 2 hr of development. The early cleavage is synchronous, but the synchrony breaks down before blastoderm formation. The peripheral cytoplasm is invaded by the cleavage nuclei within 12-18 hr of development. Anatrepsis begins when the germ cells and the posterior end of the embryonic rudiment are drawn into the posterior end of the egg. The embryo is reverted in polarity after the completion of anatrepsis. As anatrepsis ends, germ band cells proliferate to form the inner layer where segmentation begins. Appendages start appearing and the neuroblasts proliferate from the ectoderm in the thoracic region.

Cobb, P.P. 1987. Controlling southern chinch bugs on lawns and turf. Circular of the Alabama Cooperative Extension Service, Auburn University 173, 2 pp.

This circular gives a brief description of the life cycle of and the damage caused by the southern chinch bug *Blissus insularis* Barber to St. Augustine grass in southern Alabama. Control measures described include the spraying of chemicals such as Aspon, Dursban, and diazinon.

Coleman, V.R. 1971. Chinch bugs on lawns (*Blissus insularis*). Georgia University Extension Leaflet 20, 8 pp.

The southern chinch bug causes damage by sucking plant juices from the host plant. The bug is unique in that it feeds only on plants belonging to the grass family. Chinch bugs are notorious pests of St. Augustine grass lawns. The first symptom of damage is the appearance of small yellow or brown spots in the lawn. As the bugs multiply, these spots enlarge and the entire lawn gradually exhibits symptoms of injury. A brief description of the pest, its life history, and control measures are presented.

Collier, B.L., and C.E. Dieter. 1965. Dursban—a new insecticide for chinch bug and sod webworm control in St. Augustine grass. Down to Earth 21(3):3-9.

Dursban is a highly effective insecticide that is safe to mammals and nontarget organisms. This chemical was one of the prime candidates for southern chinch bug control, and studies were conducted for 3 yr to evaluate its efficiency against the pest. Dursban was compared with ethion, carbophenothion, Aspon, parathion, and carbaryl. Dursban applied at 1.0 lb active ingredient mixed with 15-40 gal of water/1,000 ft^2 of St. Augustine grass lawn provided excellent control of the pest for 8-10 wk. The insecticide was not phytotoxic.

Crocker, R.L. 1987. Control of southern chinch bug in St. Augustine grass. Progress Report of the Texas Agricultural Experiment Station 4524, pp. 34-35.

The efficacy of some insecticides in controlling the southern chinch bug in the field was tested. Chinch bugs were collected from the field and confined on St. Augustine grass turf by means of an open-ended metal cylinder (15 cm in diameter). Two experimental formulations of carbaryl (43 percent soluble liquid and 20 percent flowable), and carbaryl 80 percent soluble were tested against chlorpyrifos 0.5 granular, which acted as the standard. An untreated check was included. A high mortality of 95 percent was brought about by a high application rate of 43 percent soluble liquid carbaryl. All treatments brought about a significant reduction in population. No treatment-related phytotoxicity was observed.

Crocker, R.L. 1989. Chemical control of southern chinch bug in St. Augustine grass. Progress Report of the Texas Agricultural Experiment Station 4664, pp. 22-23.

Experiments similar to those described above were done with different insecticides. Carbaryl 43 percent soluble liquid, carbaryl UCSF-55, trimethacarb UC-27 BF32, trimethacarb UC-27BF33, fenpropathrin, acephate 75S, and a mixture of acephate 75S plus fenpropathrin were tested for their efficacy in chinch bug control. Carbaryl 43 percent was consistent with high levels of control produced in previous years. Fenpropathrin and acephate also were highly effective. No treatment-related phytotoxicity was noticed.

Crocker, R.L. 1989. Control of southern chinch bug in St. Augustine grass. Progress Report of the Texas Agricultural Experiment Station 4668, pp. 27-29.

This article is similar to the previous article and differs only in the insecticides—carbaryl, permethrin, and chlorpyrifos—used for testing. All materials significantly reduced the populations of treated insects. Again, no treatment-related phytotoxicity was noticed.

Crocker, R.L., and C.L. Simpson. 1981. Pesticide screening test for the southern chinch bug. Journal of Economic Entomology 74:730-731.

A technique for experiments on pesticide efficacy is described. This new technique helps to reduce uncontrolled experimental variability and precludes false inferences of toxicity from repellant material. This screening technique was tested in the field under caged conditions. Each pesticide was used at three levels with eight replications in a randomized complete block design. Each treatment applied an equivalent of 2.5 L/m of final product. This technique used the natural population when the numbers were low. Errors in posttreatment were counted because the bugs were confined and could not leave. The authors proposed that this technique had great potential for use in preliminary screening and rate selection tests.

Crocker, R.L., R.W. Toler, J.B. Beard, M.C. Engelke, and J.S. Kubica Brier. 1989. St. Augustine grass antibiosis to southern chinch bug (Hemiptera: Lygaeidae). Journal of Economic Entomology 82:1729-1732.

Information is presented on tests for antibiosis in St. Augustine grass to the southern chinch bug. Selected varieties and some experimental lines for resistance to the Texas strain of the southern chinch bug and Panicum mosaic virus were tested. Chinch bugs were confined in mesh-covered glass jars that contained one stolon with the apex of a selected line of St. Augustine grass. Chinch bug mortality counts were recorded daily. The lines PI 4103457, New Zealand-2, Mutant-5, TXSA-8202, TXSA-8218 and the cultivar Floratam exhibited high levels of resistance. FA-243 was susceptible and FA-82 was slower acting than Floratam. Moderate levels of resistance were observed in DALSA-8208, DALSA-8262, and DALSA-8401. Texas Common, TXSA-8262, DALSA-8203, DALSA-8207, and DALSA-8403 were susceptible to the virus.

Crocker, R.L., R.W. Toler, and C.L. Simpson. 1982. Bioassay of St. Augustine grass lines for resistance to southern chinch bug (Hemiptera: Lygaeidae) and to St. Augustine decline virus. Journal of Economic Entomology 75:515-516.

St. Augustine grass cultivars Texas Common, Florida Common, Floratam, four accessions from Africa, and eight hybrid accessions (TX series) were bioassayed in the laboratory for resistance to the southern chinch bug and to the St. Augustine decline strain of Panicum mosaic virus. Virus resistance was assayed by artificially inoculating the test plants using a standard inoculant source. Chinch bug resistance was determined based on daily mortality counts. Two hybrid accessions (TX 100 and TX 104), one accession from Africa (PI 410357), and Floratam exhibited combined resistance to the southern chinch bug and the virus. Four other hybrid accessions (TX 101, TX 102, TX 105, and TX 106), and three accessions from Africa (PI 410356, PI 410360, and PI 410364) exhibited only virus resistance.

Dahms, R.G. 1947. Oviposition and longevity of chinch bugs on seedling growing in nutrient solution. Journal of Economic Entomology 40:841-845.

The effect of different plant nutrients on resistance of sorghum to the chinch bug *Blissus leucopterus leucopterus* (Say) was determined. Finney milo and Atlas sorgo plants were used. Plants were grown in different nutrient solutions for about 12 days and then fed to the chinch bugs. On plants growing in solutions high in nitrogen and low in phosphorus, the chinch bugs laid more eggs, and vice versa. Ovipositional differences among sorghums growing in different nutrient solutions were not as large as those among different varieties grown in the same nutrient solution. Females lived longer on Finney milo plants than on Atlas sorgo. Bugs feeding on Finney milo plants growing in nutrient solution with a high nitrogen-to-phosphorus ratio laid more eggs.

Dahms, R.G. 1948. Effect of different varieties and ages of sorghum on the biology of the chinch bug. Journal of Agricultural Research 76:271-288.

The biology of the common chinch bug was studied with reference to the effect of different sorghum varieties on the longevity and fecundity of the adults. Nymphal mortality and rate of development were also studied in this context. The milos and feteritas were found to be susceptible to the chinch bug, whereas the kafirs and sorgos were resistant. Adult females on Dwarf Yellow milo laid the maxi-

mum number of eggs. Female longevity was not always correlated with the number of eggs laid. Longevity was highest on Wheatland and lowest on a sorgo variety. Nymphs on milo and feterita varieties grew larger. Plants of all varieties had fewer eggs on them when they were 25 days old than when 45 days old. The author states that resistance is due to biochemical means and is not likely to be related to the morphology of the plant.

Dahms, R.G., and F.A. Fenton. 1940. The effect of fertilizer on chinch bug resistance in sorghum. Journal of Economic Entomology 33:688-692.

Resistance of Atlas sorgo and Finney milo to the chinch bug *Blissus leucopterus leucopterus* (Say) was shown to be associated with the kind of fertilizer used. There was a decrease in resistance when sodium nitrate was added to the soil, and in the majority of cases, resistance increased with the addition of superphosphate. In essence, as levels of nitrogen increased, resistance decreased, and as levels of phosphorus increased, resistance increased.

Dahms, R.G., and M. Kagan. 1938. Egg predator of the chinch bug. Journal of Economic Entomology 31:779-780.

This is perhaps the first report of a beetle predator of the chinch bug *Blissus leucopterus leucopterus* (Say). The researcher found that *Collops quadrimaculatus* F. was always abundant in places where *Blissus leucopterus* was present and that the beetles appeared to be feeding on the chinch bug eggs. The beetles were found to feed only on the eggs and not on the nymphs or adults. The researcher also reported that one beetle can devour eggs laid by as many as five chinch bug females in 1 day.

Dahms, R.G., and J.H. Martin. 1940. Resistance of F_1 sorghum hybrids to the chinch bug. Journal of the American Society of Agronomy 32:141-147.

This is a key paper in that it is the first to describe the reaction of F_1 hybrids to chinch bug infestation. Eleven F_1 hybrids were used in a study of inheritance of resistance. Such studies have always encountered difficulties because of the hybrid vigor in sorghum. Some practical applications of the data are suggested to address the problem of breeding for resistance in sorghum. Egg count was used as a method to determine the genetics of resistance to chinch bug injury. It was concluded that resistance was dominant to susceptibility. Hybrid vigor did not seem to be associated with resistance.

Dahms, R.G., and W.M. Osborn. 1942. Effect of certain weather conditions on chinch bug abundance at the dry land field station of the USDA at Lawton, Okla., 1916-40. Ecology 23:103-106.

Chinch bug infestations were rated for 25 yr (1916-40) in a dryland field station in Oklahoma. An attempt was made to correlate infestation rates with weather parameters. Damage was graded as very light, light, moderate, severe, and very severe. Chinch bug infestation and certain weather conditions are presented in a table. The authors concluded that light infestations occurred when the amount of rainfall from July 10 to August 20 of the previous year was low. Temperatures during August had less effect than rainfall on the occurrence of chinch bug infestation the following year. Temperatures during winter and rainfall during May and June were not correlated with chinch bug outbreaks during the study period.

Dahms, R.G., and J.B. Sieglinger. 1954. Reaction of sorghum varieties to the chinch bug. Journal of Economic Entomology 47:536-537.

Reaction of some new sorghum varieties used in Texas, Oklahoma, and Kansas to injury by chinch bug *Blissus leucopterus leucopterus* (Say) was studied. Twenty-eight grain sorghums and nine forage sorghums were screened from 1946 to 1949 in Oklahoma, with some older, established varieties serving as standards. Kaferita C.I.811 was the least damaged of the varieties. Sharon Kafir was the most resistant kafir variety. Among the forage sorghums, Honey and Shallu were very susceptible, whereas a selection of Honey was much more resistant than the original Honey.

Dahms, R.G., and R.O. Snelling. 1937. Factors influencing resistance of sorghum to chinch bugs discovered. Oklahoma Agricultural Experiment Station Biennial Report 1934-1936, pp. 34-39.

In 1935, the Oklahoma Agricultural Experiment Station initiated studies on the causes of common chinch bug resistance in sorghum. The prime objective was to develop resistant varieties with desirable agronomic traits. Chinch bugs were confined on Dwarf Yellow milo, Wheatland, Honey, Kansas Orange, and Atlas sorgo—the first three being susceptible sorghum varieties. The bugs were found to lay more eggs and live longer on Dwarf Yellow milo than on any other variety tested. Atlas sorgo was the most resistant variety. There were no significant differences in the number of eggs laid or the longevity of the bugs between Wheatland (a susceptible variety) and Kansas Orange (a resistant variety). Quantitative tests to determine chinch bug resistance were performed. Sorghum varieties were infested

with 100 adult bugs when the plants were 8 inches tall, and the number of days to total plant necrosis was recorded. Laboratory results agreed with those obtained in the field. Studies on the causes for periodicity of chinch bug outbreaks were under way when this work was published.

Dahms, R.G., R.O. Snelling, and F.A. Fenton. 1936. Effect of different varieties of sorghum on biology of the chinch bug. Journal of the American Society of Agronomy 28:160-161.

Representative varieties of milo, kafir, sorgo, and feterita were used to study the effect of these sorghum races on the biology of the chinch bug *Blissus leucopterus leucopterus* (Say). Ovipositional preference studies indicated that overwintering females laid an average of 4.3 eggs on Atlas sorgo and 73.4 eggs on Dwarf Yellow milo. Females lived an average of 8.5 days on Atlas sorgo and 23 days on Dwarf Yellow milo. Next to Dwarf Yellow milo, the largest number of eggs were laid on common feterita. Fewer eggs were laid on Blackhull kafir than on the feterita variety. Nymphs passed through their immature stages in much less time on milo than those reared on resistant varieties. Mortality of nymphs on milo was only 8 percent compared to 84 percent on Atlas sorgo.

Dahms, R.G., R.O. Snelling, and F.A. Fenton. 1936. Effect of several varieties of sorghum and other host plants on the biology of the chinch bug. Journal of Economic Entomology 29:1147-1153.

The comparative biology of the common chinch bug was studied on four varieties of sorghum, Manchuria barley, Hays Golden corn, Kanota oats, Turkey wheat, sudangrass, and johnsongrass. Among the sorghum varieties, Dwarf Yellow milo and Atlas sorgo were the most and least preferred, respectively. Manchuria barley was the second most preferred host for egg laying, followed in order by Blackhull kafir, Hays Golden corn, Kanota oats, sudangrass, Turkey wheat, Atlas sorgo, and common feterita. Bugs lived longest on johnsongrass, followed by corn, barley, Dwarf Yellow milo, kafir, oats, sudangrass, wheat, Atlas sorgo, and feterita.

Davidson, R.H., and W.F. Lyon. 1979. Insect Pests of Farm, Garden, and Orchard, 7th ed. John Wiley and Sons, New York, 596 pp.

This book includes a brief description of the biology of the hairy chinch bug *Blissus leucopterus hirtus* Montandan and the damage it causes lawns and turf.

Davis, M.G.K., and D.R. Smitley. 1990. Association of thatch with populations of hairy chinch bug (Hemiptera: Lygaeidae) in turf. Journal of Economic Entomology 83:2370-2374.

Hairy chinch bugs have been shown to be abundant in places that have a thick cover of thatch. In this study, thatch was artificially induced in the field, and its relationship to hairy chinch bug abundance was determined. Chinch bug populations increased when the thatch thickness increased. Thatch was induced by the application of the fungicide mancozeb. Correlation between thatch thickness and chinch bug abundance suggested only a mathematical relationship, rather than one of cause and effect. The authors reiterated that chinch bug abundance could be related to the composition of grass species in a lawn.

Davis, M.G.K., and D.R. Smitley. 1990. Relationship of hairy chinch bug (Hemiptera: Lygaeidae) presence and abundance to parameters of the turf environment. Journal of Economic Entomology 83:2375-2379.

A survey of 108 home lawns in Lansing, MI, was conducted to identify suitable and unsuitable turfgrass environments for the hairy chinch bug. The major objective of the project was to define a relationship between turf parameters (such as thatch thickness, dry weight of grass clippings, chlorophyll content, and grass species) and the abundance of chinch bugs. A transect sampling method was used to count the bugs. A positive correlation between chinch bug abundance and thatch thickness was observed. When the lawns had more fine fescue (*Festuca rubra*) and less Kentucky bluegrass (*Poa pratensis*), the chinch bug population was high.

Deal, A.S. 1972. Southern chinch bug *Blissus insularis*. California Turfgrass Culture 22:19.

This paper is part of a longer paper entitled "Two Pests of St. Augustine Grass and Reports on One of the Most Injurious Turfgrass Pests, the Southern Chinch Bug *Blissus insularis* Barber." This pest was first found on St. Augustine grass in California in 1967, and since then has been a menace to this grass. The bugs desap the plants and cause the grass to wilt and dry in patches. The bug has two generations a year and exists in two forms, the long winged and the short winged. Diazinon is an effective insecticide that can be used at rates of 3 oz active ingredient/1,000 ft^2 of lawn surface (University of California recommendation). Other materials listed for the control of the southern chinch bugs are Akton, Aspon, Baygon, and Dursban.

Dean, G.A. 1935. Effect of season of 1934 on insect populations. Proceedings of the North Central Branch of the Entomological Society of America 14:5-6.

Extreme drought and temperature have a tremendous impact on insect populations and plants. The winter of 1933-34 was dry and mild, the normal precipitation for the year being 30-40 percent below normal. The summer of 1934 was severe with temperatures of over 110 °F for 19 consecutive days. While it is true that chinch bugs thrive under hot and dry conditions, even these conditions were too severe. Corn was about 2 ft high when the chinch bugs moved into it. Hundreds of acres of corn died due to drought. Chinch bugs died because of starvation and extremely high temperatures.

Decker, G.C. 1940. Fundamental principles which should govern the setting up of a cooperative program for the control of chinch bugs. Proceedings of the North Central Branch of the Entomological Society of America 19:73-75.

The author favors leaving chinch bug *Blissus leucopterus leucopterus* (Say) control to farmers rather than letting government agencies take over. If a cooperative program is established, it would be beneficial to follow the procedures used to control grasshoppers. The Federal Government should provide creosote and supervisory help. The state should provide supplies, conduct educational campaigns and supervise ordering. The farmers should bring paper and all materials, except creosote, and help construct barriers. All work done should be under the supervision of a state leader.

Decker, G.C. 1943. Toxic dust barriers for chinch bug control. Journal of Economic Entomology 36:658-661.

Many entomologists recommended that barriers for the common chinch bug be built using creosote. The shortage of creosote during World War II made many workers look into alternative methods. Barriers were constructed in the field with the help of 3-5-dinitro-o-cresol, dinitro-o-secondary butyl phenol, and dinitro-o-cyclohexyl phenol in pyrophillite. The barriers were highly effective in preventing migrating bugs from reaching the corn. All of the toxic dusts were also effective as killing agents when applied in postholes dug as traps in front of creosote barriers. Dusts also were effective in killing bugs that had accumulated at the base of plants.

Decker, G.C. 1944. Substitutes for creosote in chinch bug barrier construction. Journal of Economic Entomology 37:303-305.

Due to a shortage of creosote during World War II, work gained momentum to identify substitutes for creosote. Tests were done to compare old barrier materials like pine tar, road oil, and water-gas drip with newer materials like wood creosote, lignite creosote, and coal-tar creosote. Eight different forms of creosote were used in this study. Barriers 10 ft high were formed with the test materials, and three observers with stopwatches counted the bugs that crossed the barriers in 1 min. The seven oils were discarded as inferior by visual examination. All of the wood and coal-tar derivatives were found to be better than the pine tars, road oil, and water-gas drips.

Decker, G.C., and F. Andre. 1936. Studies on temperature and moisture as factors influencing winter mortality in adult chinch bugs. Iowa State College Journal of Science 10:403-420.

Chinch bugs are exposed to extreme and sudden changes in temperature and moisture during the winter months, so studies were conducted on the effect of moisture and temperature on *Blissus leucopterus leucopterus* (Say) in Iowa. Bugs were collected from bunchgrasses and brought to the laboratories. Samples of 500 bugs were exposed to various low temperatures and different moisture conditions. Results indicated that the ability of chinch bugs to withstand freezing temperatures is comparatively low and that the minimum temperatures recorded in most of the Midwestern states are sufficient to bring about 100 percent mortality. Insulation provided by an accumulation of snow, dead grass, leaf mulch, and so on is therefore very important to winter survival. Dehydration was caused by brief exposures at low relative humidity. Chinch bugs that drank water were less resistant to low temperatures than those which did not.

Decker, G.C., and F. Andre. 1937. Winter mortality of chinch bugs in Iowa. Journal of Economic Entomology 30:927-934.

Bunchgrasses were sampled in 47 Iowa counties to determine the mortality of chinch bugs during the winter. It was found that mortality varied from 20 percent to 88 percent among different locations. The areas of low, medium, and high mortality were well defined. There was no correlation between mortality and weather parameters, such as minimum temperature and mean monthly precipitation. Mortality was influenced by the average depth of snow and the amount of insulation provided by grass cover. Combinations of specific ecological conditions were correlated to chinch bug mortality.

Decker, G.C., and F. Andre. 1938. Biological notes on *Blissus iowensis* Andre (Hemiptera: Lygaeidae). Annals of the Entomological Society of America 31:457-466.

Blissus iowensis was first described by Andre in 1937. The authors discuss the relationship of this species to other members of the *Blissus* genus, present the distribution of *B. iowensis*, describe the different stages (instars), and provide information on the life history, number of generations, hibernation, oviposition, and host range. A note on the natural control of *B. iowensis* is appended.

Decker, G.C., J.H. Bigger, and H.B. Petty. 1945. Stop chinch bugs: build barriers. Illinois Agricultural Experiment Station Circular 590, 14 pp.

A brief description of the chinch bug *Blissus leucopterus leucopterus* (Say) and details about building paper, creosote, and toxic barriers to control the bugs are presented.

Decker, G.C., J.H. Bigger, and C.J. Weinmann. 1953. Spraying the margins of fields as a substitute for barrier construction in chinch bug control. Journal of Economic Entomology 46:316-320.

The relative toxicity of 12 insecticidal chemicals to the chinch bug *Blissus leucopterus leucopterus* (Say) was determined. Parathion and lindane were highly toxic, whereas DDT and TDE were the least toxic. When applied as sprays on infested small grain and corn, parathion, lindane, dieldrin, endrin, and chlordane killed almost all the bugs, but only endrin and dieldrin had sufficient residual action to prevent re-invasion for more than 2-4 days. Chinch bug migration was stopped by spraying dieldrin at the margins of corn and grain fields.

Dicke, F.F. 1937. *Eumicrosoma benefica* Gahan, as an egg parasite of the hairy chinch bug. Journal of Economic Entomology 30:376.

Eumicrosoma benefica is known as an egg parasite of the common chinch bug *Blissus leucopterus* (Say). This article is the first record of this parasite on the hairy chinch bug. The author noticed the parasite among *Blissus leucopterus hirtus* populations in Arlington, TX, in August 1934. A collection of 72 eggs from the field showed a parasitization rate of 52 percent.

Drake, C.J. 1935. The chinch bug problem—a seasonal plan of control. Proceedings of the North Central Branch of the Entomological Society of America 14:15-16.

Seasonal control of the chinch bug is a broad subject. Proper rotation and arrangement of fields and growth of crops immune and resistant to chinch bugs are discussed as two effective ways to reduce chinch bug numbers. It is recommended that susceptible crops be planted between chinch bug flights to avoid heavy infestations. The author also discusses the feasibility of other remedial measures.

Drake, C.J. 1951. New American chinch bugs (Hemiptera: Lygaeidae). Journal of the Washington Academy of Sciences 4:319-323.

The name chinch bug refers not only to members of the genus *Blissus* Klug but also to those belonging to the genera *Neoblissus* Bengroth and *Parablissus* Barber. *Blissus leucopterus leucopterus* (Say) is one of the most destructive pests in the United States. Information on two new species of *Blissus*, one new *Neoblissus* species, and descriptions of various other species are presented. An interesting fact about the *Neoblissus* spp. is that they are myrmecophilus and feed on grasses growing inside the nests of various ant species. The species of chinch bugs described are *Blissus hirtus* Montandan, *Blissus pulchellus* Montandan, *B. brasiliensis* (new species), *B. yumana* (new species), *B. richardsoni* Drake, *Neoblissus hygrobius* (Jensen-Haarup), *Neoblissus parasigaster* Bergroth, and *Neoblissus weiseri* (new species).

Drake, C.J., and G.C. Decker. 1936. The chinch bug situation in Iowa. Journal of Economic Entomology 29:781-785.

The chinch bug *Blissus leucopterus leucopterus* (Say) was first found in Iowa in 1846 and since then, it has continued to damage cereal crops in that State. Infestations were severe in 44 of the 89 yr since it was first reported. The authors describe another large outbreak of the insect in 1935, which began in 1931, in the southernmost part of the State. During this time, in many counties a partial third generation was observed in September. The fungal pathogen *Beauveria globulifera* Speg. was observed among chinch bug populations, but it did not become an epidemic until June. Heavy rains and high humidity enhanced the spread of the fungus.

Drake, C.J., G.C. Decker, and H. Gunderson. 1940. Chinch bug barrier construction. Iowa State Extension Circular 213, 15 pp.

This circular describes various methods of barrier construction.

Duble, R.L., and R.P. Carter. 1976. Effectiveness of new products on color response and chinch bug *Blissus leucopterus* control in St. Augustine turf (*Stenotaphrum secundatum*). Progress Report of the Texas Agricultural Experiment Station PR-3370C, 9 pp.

The fertilizer ferrous ammonium sulfate was taken off the market in the late 1960's. The authors encourage its reintroduction because of its importance in chinch bug control. This material produces a dramatic greening response of turf grasses due to its iron, nitrogen, and sulfur content, and it does so without promoting excessive growth. This compound was compared with Ortho lawn food, Scott's Super Turf Builder, ammonium sulfate, and an unfertilized check. In all the treatments an organophosphate insecticide, Aspon, was added. Ferrous ammonium sulfate was superior or equal to all fertilizers based on color response and treatments with Aspon at rates of 3.7, and 7.3 lb active ingredient/acre effectively reduced chinch bug numbers for 8 wk.

Dunbar, D.M. 1971. Big-eyed bugs in Connecticut lawns. Circular of the Connecticut Agricultural Experiment Station 244, 6 pp.

The purpose of this circular was to educate people about the big-eyed bugs *Geocoris bullatus* (Say) and *Geocoris uliginosus* (Say) that are often found in lawns. These bugs were frequently mistaken for the hairy chinch bug. The life history of big-eyed bugs and their feeding habits are described.

Eden, W.G., and R.L. Self. 1960. Controlling chinch bugs on St. Augustine grass lawn. Auburn Agricultural Experiment Station Progress Report 79, 3 pp.

The southern chinch bug is a destructive pest of St. Augustine grass lawns in Alabama. A brief note on the symptoms of damage, a description, and the life history of the pest are provided. The bugs were effectively controlled with one application of DDT, 10 lb/acre, as spray or granules. Zytron granules at 20 lb/acre also provided good control all summer long. Diazinon, Trithion, and some other phosphate insecticides provide control for 1 mo.

Eden, W.G., and R.L. Self. 1960. Watch out for chinch bugs. Highlights of Agricultural Research 7:2.

Southern chinch bugs collect in large numbers at the base of plants and suck the sap, resulting in yellowing and death of the plants. The first signs of chinch bug damage are small yellow spots in the lawn. The spots increase in size as the bugs increase in number. The dam-

aged plants turn from green to yellow, wither, and then die. The bugs can be controlled using DDT, VC-13, ethion, Trithion, phorate, or American Cyanamid 18133.

Emery, W.T. 1936. Chinch bug flights. Journal of Economic Entomology 29:833-837.

Flights of the common chinch bug were monitored from March to October 1935. Tanglefoot screens were set between fields of sorghum stubble and winter wheat. The catches indicated four general movements: (1) movement on wings out of overwintering quarters during March and April, (2) a shift or redistribution during May and June (3) flight of the new brood during July and August, and (4) movement into the hibernating quarters in the fall. Migration of chinch bugs out of overwintering quarters is governed mainly by changes in temperature.

Fenton, F.A., and F.E. Whitehead. 1944. Control of wheat insects. Oklahoma Agricultural Experiment Station Bulletin 275:5-46.

This bulletin describes the chief insect pests of wheat in Oklahoma, both in the field and in the bin. Methods are described for controlling them or for reducing the damage where complete control methods are unknown. The wheat insects dealt with are the green bug, chinch bug, grasshopper, armyworm, army cutworm, pale western cutworm, Hessian fly, wheat stem maggot, brown wheat mite, grain bug, wheat white grub, wireworm, false wireworm, and insects infesting stored wheat. In order to identify these insects, the bulletin gives the part of the State where an insect is most likely to be found, a description of the characteristic damage symptoms, and the time of yr when an attack is expected. The publication briefly describes the chinch bug and asserts the absence of effective control measures when the insect is on wheat.

Fitch, A. 1855. Chinch bug. Transactions of the New York State Agricultural Society 15:509-527.

The author gives an exhaustive report on the chinch bug, detailing its history as an injurious insect, its habits, and the nature of its injuries. This paper is drawn largely from statements that appeared in agricultural papers because the writer had little personal experience with the pest.

Flint, W.P. 1918. Insect enemies of the chinch bug. Journal of Economic Entomology 11:415-419.

The egg parasite *Eumicrosoma benefica* Gahan was the only natural enemy of the chinch bug that had been studied extensively before this paper was published. The paper furnishes a list of all known natural enemies of the chinch bug. One of the most efficient predators of this pest is the lady bug *Hippodamia maculata*. Ground beetles such as *Agonoderus pallipes, Harpalus compar, Evarthus sodalis*, and *Anisodactylus harpaloides* are occasionally found feeding on the chinch bug. The ant species *Solenopsis molesta* and *Monomorium* sp. have been found to carry chinch bug eggs to their nests. The common green lacewings *Chrysopa rufilabris* and *C. oculata* are excellent predators of chinch bug nymphs. Information on the nabid *Pagasa fusca*, the damsel bug *Reduviolus ferus*, the predatory flower bug *Triphleps insidiosus*, and the striped ground beetle *Agonoderus pallipes* is also provided.

Flint, W.P. 1918. Suggestions for a new method of destroying chinch bugs. Journal of Economic Entomology 11:186-188.

This is an interesting paper that suggests a new method (in 1918) of combating the chinch bug *Blissus leucopterus leucopterus* (Say). While making field observations of the bug in a dry field with stubble, the author noticed that chinch bugs collected in large numbers on any moist object on the ground. Chinch bugs on a moist gunnysack, which was used to protect a water jug, inserted their mouth parts in the sack and were sucking water from it. This led the author to surmise that chinch bugs could be killed if an appropriate soluble poison were added to water. Laboratory experiments were conducted by placing chinch bugs in open boxes, the sides of which were chalked to prevent the bugs from escaping. Sodium arsenite at various concentrations was dissolved in water and used to moisten bran that was fed to the bugs. A very high percentage of bugs died that fed on bran wet with sodium arsenite.

The following year (1917) experiments were conducted in a wheat field. Creosote barriers were made around the field, and a number of substances wet with sodium arsenite, lead acetate, and sodium cyanide were placed along the inside of the barrier. Sodium arsenite was not very effective this time. Lead acetate was the most effective poison, followed by sodium cyanide. The author tried to make the lead acetate solution more attractive by adding corn stalk juice without any enhanced effect.

Flint, W.P. 1921. Chinch bug resistance shown by certain varieties of corn. Journal of Economic Entomology 14:83-85.

Seven varieties of corn, namely, White Democrat, Iowa Silver Mine, Boone County White, Sutton's Favorite, St. Charles County White, Yellow Ninety Day, and Reid's Yellow Dent, were planted in a field where chinch bugs were abundant. These varieties were screened for chinch bug *Blissus leucopterus leucopterus* (Say) resistance. In the first year of screening, Reid's Yellow Dent proved to be the most resistant cultivar. During this time, there were also reports from many farmers that White Democrat was withstanding chinch bug damage very efficiently. So the next year, Reid's Yellow Dent and White Democrat were sown in alternate strips of two rows each. At least 80 percent of White Democrat plants were standing when all the Reid's Yellow Dent plants had nearly fallen because of chinch bug injury. There were significant yield differences between the two varieties. In 1920, further tests were done with White Democrat, Black Hawk, St. Charles County White, Arlington Prolific, Pride of Saline, U.S. Selection 77, Freed W. Dent, Colby Bloody Butcher, Lancaster Surecrop, North Western Dent, and Gehu. White Democrat, Black Hawk, and St. Charles County White demonstrated high levels of chinch bug resistance and were recommended for cultivation.

Flint, W.P. 1922. Burn the chinch bug. Illinois Agricultural Experiment Station Circular 265, 4 pp.

This circular is written in question-and-answer form. It provides information on the damage to Illinois farms from the common chinch bug, other states threatened by this pest (such as Nebraska, Kansas, Oklahoma, Missouri, Ohio, Iowa, Indiana, and Michigan), crops damaged, and overwintering places. Even though chinch bugs take refuge in woodlands, burning an entire woodland is unwarranted. Not many bugs can be killed by burning stubbles in the field. The best time to burn overwintering quarters is from November to April. Burning not only kills the bugs directly but also destroys the cover, exposing the bugs to extremely cold weather. The circular also advises the farmers to work the fire against the wind to get the best results. A substantial percentage of the bugs can be killed this way and the population buildup during the following season will be minimized.

Flint, W.P. 1923. Chinch bug barriers. Illinois Agricultural Experiment Station Circular 270, 8 pp.

Information is given about the different kinds of barriers and their effectiveness in keeping chinch bugs at bay.

Flint, W.P. 1935. The chinch bug. Journal of Economic Entomology 28:333-341.

This article is a minireview of some of the important work done with the chinch bug up to 1935, including aspects of chinch bug ecology. One of the most important pieces of information is that in the spring the bugs fly out of their overwintering sites on sunny days when the temperature is above 70 °F. There will be considerable activity in the winter quarters before migration begins. The author also writes about the short-winged and long-winged forms of the chinch bug in Illinois. An account of the food habits, host plants, diseases, and control of the chinch bug is presented.

Flint, W.P. 1940. How to stop chinch bug losses. Illinois Agricultural Experiment Station Circular 505, 15 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) is one of the most destructive pests attacking corn and sorghum in Illinois. Chinch bug populations are influenced by changes in weather parameters. A hot, dry season has always brought a higher incidence of bugs. Infestation levels are reduced when there are frequent heavy rains late in May or June. The white fungus *Sporotrichium globuliferum* develops and spreads rapidly when the weather is damp. Chinch bugs have been known to survive extreme cold, and a mortality rate of only 6-10 percent is observed in overwintering quarters. Many people suggest burning crop refuse and bunchgrasses in winter to control chinch bugs, but the author contends that "winter burning seldom pays." Less than 25 percent of the bugs are killed by winter burning.

The best way to control a pest is to understand its life cycle and to initiate control measures at a stage when the pest is most vulnerable. The cheapest and most effective method of combating this pest is to grow chinch-bug-proof crops, like alfalfa, red clover, sweet clover, sunflowers, flax, buckwheat, sugarbeets, soybeans, cowpeas, artichokes, potatoes, and rape. Crop rotations of corn with soybean, oats (or wheat), and clover are very effective in keeping chinch bugs population to a minimum. Using various kinds of barriers and growing resistant varieties are also effective ways of stopping losses. A pictorial representation of the bug's life history is given.

Flint, W.P., and W.V. Balduf. 1924. Calcium cyanide for chinch bug control. Illinois Agricultural Experiment Station Circular 249:71-84.

An account of the experiments using a new chemical substance to combat chinch bugs is reported. In 1922, calcium cyanide was used for the first time to control chinch bugs. Calcium cyanide was (1)

laid in strips at right angles to a barrier, (2) scattered along a creosote barrier, (3) dusted over a strip of trap crops, or (4) used alone as a barrier. The best results were obtained when calcium cyanide dust or granules were used in combination with creosote or coal-tar barriers. Dusting calcium cyanide on trap crops gave fair control. It was very costly and ineffective to use calcium cyanide alone as a barrier material.

Flint, W.P., and W.L. Burlison. 1920. Crop rotations to starve the chinch bugs. Illinois Agricultural Experiment Station Circular 39, 4 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) is a pest on crops belonging to the grass family. The most commonly attacked crops are corn, sorghum, wheat, barley, oats, rye, millet, broomcorn, barngrass, and foxtail. The bugs also feed on a variety of native and introduced bunchgrasses. They cause damage by desapping green and succulent plants. One of the best ways of controlling this notorious pest is to adopt crop rotations that factor in its food habits. Information on five different crop rotations for different counties is provided. A map of various counties in Illinois is appended.

Flint, W.P., and R.G. Dahms. 1935. Reduce chinch bug damage by crop rotations. Illinois Agricultural Experiment Station Circular 430, 4 pp.

This circular is very similar to the previous one in that crop rotations are recommended to reduce chinch-bug-related losses. Major grain crops are rotated with soybeans, wheat (or rye), and clover to decrease chinch bug populations.

Flint, W.P., G.H. Dungan, and J.H. Bigger. 1934. Fighting the chinch bugs on Illinois farms. Illinois Agricultural Experiment Station Circular 419, 15 pp.

The publication includes a brief description of the habits and life history of the chinch bug *Blissus leucopterus leucopterus* (Say) and weather parameters controlling chinch bug abundance. The emphasis is on methods of controlling this destructive pest. The most important control strategies presented are (1) growing bug-resistant or immune crops (the least expensive and most effective method), (2) rotating crops, (3) growing crop mixtures, and (4) using barriers and traps.

Flint, W.P., G.H. Dungan, and J.H. Bigger. 1935. Fighting the chinch bugs on Illinois farms. Illinois Agricultural Experiment Station Circular 431, 16 pp.

This is a revision of the aforementioned 1934 circular.

Flint, W.P., and J.C. Hackleman. 1923. Corn varieties for chinch bug infested areas. Illinois Agricultural Experiment Station Circular 243:539-550.

Experiments were conducted with various corn varieties to screen for chinch bug resistance. Champion White Pearl, Democrat, Black Hawk, Golden Beauty, Mohawk, St. Charles County White, and Commercial White were some of the resistant corn varieties recommended for cultivation where chinch bugs were a problem.

Flint, W.P., and W.H. Larrimer. 1934. The chinch bug and how to fight it. Farmers Bulletin, U.S. Department of Agriculture 1498, 18 pp.

The chinch bug is one of the most destructive pests of grain and grass crops in the United States. The bugs pass through two generations each yr, overwintering as adults in bunchgrasses. They prefer a mixture of grasses and leaves for overwintering. The bugs fly out of the winter quarters on bright sunny days when the temperature is above 70 °F. A pictorial representation of the chinch bug's seasonal history is presented.

Females lay an average of 150 eggs in the ground, on plants, or on roots if the ground is cracked. The eggs hatch in 7-45 days, depending mainly upon the temperature. The insects pass through five nymphal instars before they become adults. They attack a variety of plants like corn, sorghum, broomcorn, millet, wild and cultivated grasses, wheat, barley, oats, and rye. They do not feed on clover, alfalfa, vetch, lespedeza, soybeans, cowpeas, sweet clover, and peanuts. Natural enemies cannot bring down chinch bug populations. Populations can be controlled chiefly by (1) burning the bugs in their winter quarters, (2) growing crops on which they do not feed, and (3) killing the bugs by using barriers, sprays, and dusts.

Forbes, S.A. 1883. Early occurrence of the chinch bug in the Mississippi Valley. U.S. Department of Agriculture, Division of Entomology, Insect Life 1, 249 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) was apparently an important agricultural pest in Illinois from almost the start of farming there. This publication documents evidence that a crop of oats on a farm in southern Illinois was damaged by the chinch bug in 1823.

Forbes, S.A. 1892. The chinch bug in Illinois, 1891-1892. Illinois Agricultural Experiment Station Bulletin 19:44-48.

The common chinch bug population experienced a sharp increase during 1891 and 1892 in most parts of south central Illinois. The

author attributed this to uniformly high temperatures and low precipitation. A belt of counties extending from the Ohio and Mississippi Railroad toward Springfield was threatened. Brief abstracts of the author's field notes indicate the chinch bug situation in most parts of the State. The bulletin recommends destroying the bugs in their winter quarters trapping them in field furrows and then killing them mechanically by pouring in kerosene emulsion. Individual measures to control the bug will not yield good results. A cooperative effort is necessary to combat these pests.

Forbes, S.A. 1894. The chinch bug in Southern Illinois. Illinois Agricultural Experiment Station Bulletin 33:397-400.

In 1892, prevailing temperature conditions fueled predictions that there would be an extensive outbreak of the chinch bug *Blissus leucopterus leucopterus* (Say) in the southern part of Illinois. This bulletin reports the chinch bug situation in 1894. Eight counties in south and south central Illinois had very high chinch bug populations. Eighteen other counties had medium to high populations. The only control measures then available were either to use the infectious muscardine fungus or to build barriers between small grains and other crops. The construction of two parallel furrows instead of one (as reported in bulletin no. 19, abstract following) is suggested. Chinch bugs escaping from the outer furrow can be killed in the second furrow. The use of trap crops to concentrate chinch bugs away from corn is also suggested.

Forbes, S.A. 1896. Noxious and beneficial insects. Illinois State Entomologists' Report No. 19, pp. 3-189.

In this 19th report Forbes writes about the importance of chinch bugs to Illinois crop production. He refers to the chinch bug as a destructive and unmanageable pest of grain fields. This pest taxed the farmer more than all other pests combined. According to the author, the cause of the chinch bug abundance is uncertain.

Forbes, S.A. 1916. The chinch bug outbreak of 1910 to 1915. Illinois Agricultural Experiment Station Circular 189, 59 pp.

A destructive outbreak of the chinch bug *Blissus leucopterus leucopterus* (Say) is described. The beginnings were seen in Illinois in the fall 1909, and the outbreak continued with growing intensity and gradually spread in the area until the spring 1915, when it suddenly collapsed. This bulletin provides a detailed computation of losses and secondary economic consequences. The outbreak was attributed to the unusually hot midsummer weather with no excessive rainfall that occurred in an area where the food plants of the chinch bug

abounded. The expansion of this outbreak from the area occupied in 1910 may have been due to an overflow from the heavily infested territory, the direction of which was, in part, governed by the cropping pattern in adjacent areas. The outbreak concluded in the spring and early summer of 1915 because of beating and flooding rains when the young bugs were hatching from the egg.

Remedial measures are described, such as winter burning, destruction of the bugs during wheat harvesting, use of coal tar for constructing barriers, use of insecticidal sprays such as kerosene emulsion, tobacco preparations, and soap solutions, and passing legislation to stop chinch bug outbreaks.

Foster, D.E., and H.J. Stockdale. 1982. Field corn chinch bug control. Insecticide and Acaricide Tests 7:147-148.

The efficacy of some experimental and registered insecticides in controlling chinch bugs was evaluated in two commercial fields in Iowa. Eight insecticides were tested and each treatment was applied using a backpack sprayer equipped with drop nozzles and Teejet 65015 tips directed at the base of the plant. The number of chinch bugs per plant was recorded 1 and 3 days after spraying. All treatments, except toxaphene and Trithion 0.5 lb active ingredient/acre, performed significantly better than the 1-day posttreatment. Furadan, Sevin, and Sumithion performed significantly better than all others 3 days after treatment.

Gannon, N., and G.C. Decker. 1955. Field evaluation of sprays for chinch bug control. Journal of Economic Entomology 48:242-245.

This work is a continuation of the previous paper. This study was conducted in the field using nine insecticides under light, medium, and heavy migration of the chinch bug. Early in the season when chinch bugs had just migrated into wheat from their winter quarters, 0.5 lb of dieldrin/acre gave good control. Of the insecticides applied as barrier sprays, only endrin and dieldrin remained effective throughout the entire migration. Parathion and lindane, despite their high toxicity, were not effective against migrating chinch bugs 3 days after spraying. Aldrin gave good results under light and moderate migration. Heptachlor, toxaphene, chlordane, and DDT were ineffective.

Gannon, N., and G.C. Decker. 1955. Insecticide tests against the chinch bug in the laboratory. Journal of Economic Entomology 48:240-242.

This paper was published when insecticidal control was perceived as the best method of controlling chinch bugs. The relative toxicities

and residual effectiveness of eight insecticides were evaluated in the laboratory. Contact toxicity tests were performed by confining bugs in an insecticide-treated carton for half an hour and letting bugs loose on soil treated with a prescribed amount of the insecticide. Endrin was the most effective insecticide. It had the highest mortality and was the most persistent. Parathion and lindane were as toxic as endrin but were less persistent. Aldrin, heptachlor, chlordane, toxaphene, and DDT were all relatively nontoxic to the insect. The authors conclude that if migration is not a factor, all the tested materials could be equally effective at proper dosage levels.

Garman, H. 1898. The chinch bug. Bulletin of the Kentucky Agricultural Experiment Station 74:43-70.

The chinch bug *Blissus leucopterus leucopterus* (Say) has been found in Kentucky since 1889 but started damaging crops after 1896. This bulletin provides a brief description of the insect, its habits, and natural enemies. The fungus *Sporotrichium globuliferum* is described in detail. Methods of growing and using the fungus are provided, and attention is called to the fact that the station will furnish packages of the chinch bug fungus for experimentation. Figures of the chinch bug, the fungus, fungus-infected bugs, fungus in culture, and maps of Kentucky showing chinch bug distribution are included.

Gracen, V.E., and W.D. Guthrie. 1986. Host plant resistance for insect control in some important crop plants. Critical Review of Plant Science 4:277-291.

An account of the importance of plant resistance in the management of the chinch bug is presented. The authors state that the chinch bug *Blissus leucopterus leucopterus* (Say) used to be a major pest of sorghum, but the development of resistant varieties has relegated the chinch bug to a minor pest status in recent years. Resistance is apparently controlled by a single dominant gene in certain crosses. Resistance is usually dominant, but the number of genes involved is not known.

Guthrie, F.E., and G.C. Decker. 1954. The effect of humidity and other factors on the upper thermal points of the chinch bug. Journal of Economic Entomology 47:882-887.

A physiological study of the chinch bug *Blissus leucopterus leucopterus* (Say) was conducted to determine the effect of humidity on the upper thermal death points of fed and unfed bugs during exposure to high lethal temperatures. Eight temperatures and five relative humidity levels were tested. As temperature increased, the

effect of humidity on the upper thermal mortality of unfed bugs decreased. An equilibrium point was reached at about 50 °C where mortality was the same regardless of the relative humidity. Survival was favored by high humidities at lower temperatures and vice versa. When moisture was provided through a food source, longevity increased and desiccation became less important as a cause of death.

Hamilton, C.C. 1935. The control of insect pests of lawns and golf courses. New Jersey Agricultural Experiment Station Circular 347, pp. 1-16.

The insects discussed in this review of pests of lawns and golf courses are the white grubs, sod webworms, cutworms, armyworms, grasshoppers, chinch bugs, some plant bugs, ants, and some miscellaneous insect pests such as seedcorn beetles, dog fleas, and cat fleas. Most of these insects are described based on their life history and habits, nature of injury to turf, and methods of control. The author recommends derris dust for chinch bug control. Nicotine dust, nicotine, and pyrethrum soap sprays are other natural products cited as being effective control substances.

Hamman, P.J. 1969. Control of southern chinch bug *Blissus insularis* in Brazos County, Texas. Proceedings of the Scotts Turfgrass Research Conference 1:15-17.

The southern chinch bug is the most important pest on turf grass in Brazos County, TX. This paper embodies observations of 2 yr of research on the effect of chemicals on the southern chinch bug. Demonstrations were conducted on 10 home lawns. The insecticides used were Dursban, ethion, Trithion, Akton, and Aspon + DDT. Both the emulsified concentrate and granular formulations of these insecticides were tested. Efficacy of the chemicals was determined based on pre- and posttreatment population counts. Dursban, Akton, and Aspon + DDT in either form produced satisfactory control.

Harris, H.M., and G.C. Decker. 1934. Paper barriers for chinch bug control. Journal of Economic Entomology 27:854-857.

Various kinds of paper barriers have been used for chinch bug control for a long time. This practice was considered the most feasible technique to prevent or reduce crop losses from immigrating bug populations. The creosote barrier was the most practical and effective of all the barriers, but in spite of its effectiveness, it had

some problems. When there was a strong gust of wind, many bugs were blown past these barriers into the fields. To circumvent this problem, the authors conducted experiments in Iowa, using paper barriers made of creosote-soaked paper. These were placed upright in a groove and the soil was filled in and tamped to the same level on both sides. Holes were dug at regular intervals along the line on the small grain side of the paper. A 4.5-inch strip of paper gave the best results. The authors also describe various modifications to the barrier based on soil type and soil compaction. The kinds of paper used were red rosin building paper, felt building paper, regular tarred felt, and a single-faced corrugated board of chip and straw composition.

Haseman, L. 1913. The chinch bug and its control. Missouri Agricultural College Experiment Station Circular 62:211-214.

This circular describes in detail the chinch bug *Blissus leucopterus leucopterus* (Say) in Missouri. The history of the chinch bug in Missouri, the insects' life history and habits, and methods of control are discussed.

Haseman, L. 1920. Insect pests of field crops. Missouri Agricultural Experiment Station Bulletin 170, pp. 1-39.

In this review the crops included are corn, wheat, legumes, cotton, grains, and seeds. Some of the insects featured are corn rootworm, wireworm, white grub, corn bill beetle, earworm, chinch bug, and Hessian fly. Notes on the life histories of these insects, morphologies, damage caused, and control measures are included.

Haseman, L., and S.W. Bromley. 1924. Controlling chinch bugs in Missouri with calcium cyanide. Journal of Economic Entomology 17:324-329.

Preliminary experiments with a then new control substance, namely, calcium cyanide, are presented. Calcium cyanide was first used as a fumigant in rodent tunnels. It was tested in Illinois for controlling chinch bugs by Flint (the first to use this compound against the chinch bug). When in contact with air, calcium cyanide releases hydrocyanic acid gas, which is toxic to insects. When used at the rate of 1 lb/60 ft in a furrow, the material was very effective. Best results were obtained when the compound was applied in the early afternoon when migrations began. The material was also used to form a narrow barrier strip with a trap crop. This did not give satisfactory results. The success of the barrier was influenced by temperature, moisture, and wind.

Hayes, W.P., and C.O. Johnston. 1925. The reaction of certain varieties of grasses to chinch bug attack. Journal of Agricultural Research 31:575-583.

It is well known that chinch bugs *Blissus leucopterus leucopterus* (Say) hibernate in bunchgrasses during winter. Although many workers reported the damage to cultivated crops by the chinch bug, no one had really reported the extent of damage to grasses. This key paper on that subject greatly extends the previous list of known food plants of this insect and discusses the degree of injury to the host plants and their ability to recover from injury. A table with all known host grasses is presented, along with information on their common names, whether they are annual, perennial, native, or introduced, type of growth and time of maturity, habitat, chinch bug injury, and percentage of recovery. Native perennial species with tough tissues were resistant to chinch bug attacks and exhibited a marked ability to recover.

Headlee, T.J., and J.W. McColloch. 1913. The chinch bug. Kansas Agricultural Experiment Station Bulletin 191:287-353.

An account of the chinch bug *Blissus leucopterus leucopterus* (Say) in Kansas is presented. The authors discuss the plausibility of Webster's theory of the natural spread of the chinch bug in the United States and conclude that the chinch bug was already in Kansas when settlers arrived. This work is a comprehensive review of the habit and life history of the chinch bug, its life cycle in Kansas (explained using a diagram), nature and extent of damage, effect of climatic factors, and aspects of control. According to the writers, the chinch bug has no efficient natural enemies other than the parasitic fungus *Sporotrichium globuliferum*. It is reported that it is impossible to hasten the progress of this disease by artificial distribution of the fungus. The chinch bug can be controlled effectively by destruction of its winter quarters.

Henry, T.J., and D.J. Hilburn. 1990. An annotated list of the true bugs (Heteroptera) of Bermuda (North Atlantic Ocean). Proceedings of the Entomological Society of Washington 92:675-684.

This paper lists about 45 species of Heteroptera from Bermuda that belong to 14 families. There are 19 new island records included in this paper. The general distribution of each species, their hosts, and collection records are reported. Chinch bugs are included.

Holbert, J.R., W.P. Flint, and J.H. Bigger. 1934. Chinch bug resistance in corn: an inherited character. Journal of Economic Entomology 37:121-124.

A number of inbred corn lines were developed as a result of cooperative corn investigations in central Illinois. Hybrids were then developed from these. These were subjected to chinch bug *Blissus leucopterus leucopterus* (Say) infestations for the first time in 1933. Data about damage suggested that some inbreds carried dominant factors for chinch bug resistance and some carried dominant factors for susceptibility. The results also suggested that strains of corn could be developed that combine chinch bug resistance with other important characteristics.

Holbert, J.R., W.P. Flint, and G.H. Dungan. 1935. Resistance and susceptibility of corn strains to second brood chinch bugs. Iowa State College Journal of Science 9:413-426.

The construction of barriers around fields helps to keep the first brood of bugs from moving into cornfields, but there are no measures to stop the adults of this brood from moving into corn. The best way to counter this problem is to grow resistant varieties or hybrids of corn. The development of resistant strains allows the grower to benefit from the crop in spite of chinch bug infestation. It has already been reported by Flint and Hackleman (1923) that Democrat and some strains of Golden Beauty are resistant varieties giving good yields.

A total of 39 cooperative experimental yield trials were conducted in 1934 in 10 central Illinois counties. Three groups of hybrids were tested for chinch bug resistance. Hybrid 391 yielded more than Democrat and Waddel Golden Beauty did under heavy pest infestation. The development of high-yielding resistant hybrids of corn specific to different sections of the State is highlighted in this paper. It was seen in all the counties that chinch-bug-resistant hybrids also yielded more than did the susceptible ones.

Horn, G.C. 1962. Chinch bugs and fertilizers, is there a relationship? Florida Turf Grass Association Bulletin 9(4):3-5.

Inorganic sources of nitrogen make grass grow well because nitrogen is quickly made available to the plants. Under these conditions, the grass is likely to suffer more chinch bug damage. Populations develop more rapidly and cause more injury on heavily fertilized grass than on grass receiving moderate amounts of nitrogen or nitrogen slowly released from an organic source.

Horn, G.C., A.E. Dudeck, and R.W. Toler. 1973. 'Floratum' St. Augustine grass, a fast growing new variety for ornamental turf, resistant to St. Augustine grass decline and chinch bugs. Florida Agricultural Experiment Station Circular 224, 13 pp.

The major problems encountered in St. Augustine grass lawns are those imposed by southern chinch bugs and St. Augustine decline (SAD) virus. Accessions of this grass from Florida and other areas were screened for resistance to SAD and insect pests. Floratam exhibited resistance to the virus and the chinch bug. This cultivar is vigorous and rapidly establishes a ground cover. It is tolerant to many other diseases and has superior color. This circular provides a taxonomic description of Floratam, basic information on its growth characteristics, and methods of propagation, establishment, and maintenance of established lawns.

Horton, J.R., and A.F. Satterthwait. 1922. The chinch bug and its control. U.S. Department of Agriculture Farmers Bulletin 1223, 35 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) has damaged crops in the United States since 1783 when this pest overran wheat in North Carolina. The bulletin reports a total loss every yr of $46 million worth of corn, wheat, oats, and forage sorghums in the United States because of this insect. Chinch bugs cause damage by sucking sap from plants. Feeding imparts a reddish stain to the part attacked, and then the attacked plant cell dies. The bulletin describes the various stages of the chinch bug, its food plants (members of the grass family), its life history, migratory habits, and control measures. Chinch bugs can be destroyed by burning grasses in November and December or by spraying the bugs with an oil-emulsion of nicotine sulfate. The authors reiterate that the cooperation of neighborhoods in executing chinch bug control measures is of vital importance.

Howard, L.O. 1888. The chinch bug. U.S. Department of Agriculture, Division of Entomology 17, 48 pp.

This is a summary obtained from the study of the chinch bug *Blissus leucopterus leucopterus* (Say) up to 1888. Interesting information on distribution and injuries is given, especially for the yr 1887.

Janes, M.J. 1935. Oviposition studies on the chinch bug, *Blissus leucopterus* (Say). Annals of the Entomological Society of America 28:109-120.

This is perhaps the first exclusive study on the egg-laying potential of the chinch bug *Blissus leucopterus leucopterus* (Say). Studies were

conducted under constant temperature conditions of 24.5 °C, 29.5 °C, and 34.5 °C. The relative humidity ranged from 70 percent to 100 percent. Eighty-one females belonging to various groups such as overwintered, first generation, and second generation were used. Females were reared on young wheat shoots, and each female was allowed to mate with one male. Egg counts were made regularly at 24-hr intervals, and each female was dissected at the time of death to count the number of eggs in her ovaries. Overwintered females laid the maximum number of eggs, an average of 544. Females belonging to this group laid more eggs than those of the first and second generations. Egg production was highest at 29.5 °C. First-generation females laid an average of 532 eggs and the second generation laid an average of 502 eggs.

Janes, M.J. 1937. Studies of certain phases of the biology of the chinch bug, *Blissus leucopterus* (Say), under conditions of constant temperature and constant relative humidity. Iowa State College Journal of Science 22:132-133.

Studies on the effect of temperature and humidity on certain aspects of chinch bug biology were conducted from 1933. Thirty-four pairs of overwintered bugs, 34 pairs of first-generation bugs, and 13 pairs of second-generation bugs were used in various studies. Bugs were reared on wheat plants, one pair per plant. The bugs were subjected to constant temperatures of 24.5 °C, 29.5 °C, and 34.5 °C. The ideal temperature for egg laying was 29.5 °C, which resulted in an average of 598 eggs. At 24.5 °C, the average number of eggs laid was 532, and at 34.5 °C it was 502. The preoviposition period was shortest at 34.5 °C (2 days) and longest at 29.5 °C.

Males were found to live longer than females. First-generation females laid fewer eggs than overwintered females, and second-generation bugs laid even fewer eggs. Eggs were incubated at 19.5 °C, 24.5 °C, 29.5 °C, and 34.5 °C. The relative humidities used were 20 percent, 40 percent, 60 percent, 80 percent, and 100 percent. Eggs hatched in 7 days at 34.5 °C and in 30 days at 19.5 °C. As the temperature increased, the amount of time for the eggs to hatch decreased. The most favorable relative humidity at high temperatures was 80 percent. Relative humidity had its greatest influence on the percentage of eggs hatched.

Janes, M.J., A. Hayes, and G.E. Garman. 1935. Preliminary studies on starvation and drowning of the chinch bug, *Blissus leucopterus* (Say). Journal of Economic Entomology 28:638-647.

The ability of the chinch bug to withstand starvation and submergence in water was examined. After being deprived of food and

water for periods varying from 8 hr to 13 days, the bugs were alive and able to resume normal activities. High temperature or low humidity was the most destructive to the starving insects. Longevity increased when bugs had access to a sucrose solution or distilled water. Bugs recovered and resumed normal activity even after being submerged in water for 48 hr.

Jones, G.D. 1940. New development in chinch bug control. Proceedings of the North Central Branch of the Entomological Society of America 19:71-73.

This paper describes new methods of controlling this pest. Creosote paper barriers have been more effective in controlling chinch bugs than any other barrier. Interplanting soybeans with corn helps to reduce chinch bug infestation. The use of resistant or tolerant corn and sorghum varieties is perhaps the most effective and least expensive method of control. A new cropping system is suggested where barley or wheat, corn, and lespedeza are grown in rotation. The effect of this system on chinch bug population was to be determined by future studies.

Kelly, E.O.G., and T.H. Parks. 1911. Chinch bug investigations west of the Mississippi River. U.S. Department of Agriculture, Bureau of Entomology, Bulletin No. 95, Part 3, 52 pp.

This paper was written to give farmers information about the habits of the chinch bug *Blissus leucopterus leucopterus* (Say) and the most effective methods of combating it. Information on chinch bug distribution, number of generations, migration, and pest status in Missouri, Kansas, and Oklahoma is given. The remedial measures suggested are the following: (1) burning red sedge grass where most of the chinch bugs hibernate, which can kill up to 75 percent of them, (2) use of dust and coal-tar barriers to restrict migration from wheat to corn, (3) killing the bugs when they are massed on the first few rows of corn by applying a torch or spraying with kerosene emulsion, and (4) use of the white fungus under moist conditions to lower populations.

Kelsheimer, E.G., and S.H. Kerr. 1957. Insects and other pests of lawns and turf. Florida Agricultural Experiment Station Circular 96, pp. 1-5.

In this brief review, the insects included are chinch bugs, sod webworms, armyworms, mole crickets, white grubs, leafhoppers, scale insects, false chinch bugs, mound-building bees, ants, earwigs, and fleas. Also included are notes on centipedes, nematodes, snails, and slugs. Control measures are discussed.

Kennedy, M.K., and R.L. Lawrence. 1981. Chinch bugs: biology and control. East Michigan State University Cooperative Extension Service, Extension Bulletin, 3 pp.

A brief account of the life history of *Blissus leucopterus leucopterus* (Say) is presented along with discussion of some control tactics.

Kerr, S.H. 1956. Chinch bug control on lawns in Florida. Journal of Economic Entomology 49:83-85.

Studies of chinch bugs have been conducted in various areas of Florida, and over the yr, these studies have provided data that vary from study to study. In order to learn why these variations occur and to refine control tactics, the author conducted experiments. Seven insecticides were tested for their efficacy against the chinch bug on lawns in Florida. All treatments were applied at 7- to 10-day intervals and were replicated three times. Parathion and DDT were effective against the bugs in all test locations. Chlordane performed well when used on thin turf but was not as effective on thick turf. Dieldrin, demeton, and Strobane followed the same trend as chlordane did. In essence, most of the materials gave satisfactory results on thin turf, but under extreme conditions all of the chemicals failed except parathion and DDT.

Kerr, S.H. 1956. Chinch bug control tests—1955. The Florida Entomologist 39:61-64.

This paper closely follows the preceding paper. Trials were conducted using DDT, parathion, malathion, lindane, and dieldrin. The author was especially interested in the performance of malathion because it was about to be used as a substitute for parathion, which was banned in one community. Pretreatment counts of southern chinch bugs were made by sampling 1 ft^2 of each plot using the flotation method. Plots were divided into groups having high, moderate, and low chinch bug populations. The chemicals were applied twice, the second application 35 days after the first. Malathion failed to give satisfactory control. Even though the average number of bugs in some lindane plots was high, this material gave satisfactory control. There were no differences in the control effected by granular or emulsion formulations. All materials, except malathion, gave good control 4 wk after treatment. Residual effectiveness of DDT was prolonged up to 6 wk.

Kerr, S.H. 1962. Lawn insect studies. Proceedings of the University of Florida Turf Grass Management Conference 10:201-208.

This paper describes studies of the chinch bug *Blissus insularis* Barber, including experiments with natural enemies and resistant varieties. Some strains of the fungus *Beauveria bassiana* and the nematode *Neoaplactana glaseri* infect lawn chinch bugs. Studies with these two natural enemies proved to be inconclusive. It has not been shown that these two organisms have practical utility in chinch bug control. The author showed that chinch bugs developed slowly and laid fewer eggs in some strains of St. Augustine grass than in others. Different strains of this grass were found to have different susceptibilities to the chinch bug.

Kerr, S.H. 1966. Biology of the lawn chinch bug. The Florida Entomologist 49:9-18.

This is an important paper in that it describes the biology of the lawn chinch bug *Blissus insularis* Barber and gives some basic information for the geographical areas involved. The life history was studied in the laboratory. Adult chinch bugs were collected from the field, kept in petri dishes, and fed St. Augustine grass runners. The eggs were separated at regular intervals. Nymphs were exposed to two temperatures, 83 °F and 70 °F. The average nymphal duration was 34.7 days at 83 °F and 93.4 days at 70 °F. The insects passed through five nymphal stages. Adult males survived for 42 days and females survived for 70 days. Females laid an average of 289 eggs.

There are no large spring flights in *B. insularis*, unlike in *B. leucopterus*. These chinch bugs move from lawn to lawn on foot. In Florida, the lawn chinch bug also feeds on centipede grass [*Eremochloa ophiuroides* (Munro) Hackel], zoysiagrass (*Zoysia* spp.), bahiagrass (*Paspalam notatum* Fluegge.), bermudagrass [*Cynodon dactylon* (L.)], and torpedograss (*Panicum repens* L.). The chinch bugs are seen in great numbers when temperatures are high. In the cooler winter mo, the population decreases greatly. Seasons with very high rainfall witness very low insect populations.

Kerr, S.H., and L.C. Kuitert. 1955. Biology and control of insect and arachnid pests of turf grasses. Florida Agricultural Experiment Station Annual Report 101-102.

Six insecticides—DDT (10 lb), chlordane (10 lb), dieldrin (5 lb), demeton (1 lb), parathion (1.5 lb), and Strobane (4 lb)—were used in southern chinch bug control trials conducted on lawns in several

locations in Florida. Many chemicals gave satisfactory control when used on thin turf but did not do quite as well under well-established turf. DDT applied as an emulsion concentrate gave good control at all test locations.

Kerr, S.H., and F.A. Robinson. 1958. Chinch bug control tests. 1956. The Florida Entomologist 41:97-101.

The authors conducted a series of tests to screen additional chemicals for control of chinch bug *Blissus insularis* Barber. In 1956, parathion, Thimet, Sevin, C&C 8305, diazinon, OS 2046, V-C 13, chlorthion, Dylox, and guthion were evaluated. Parathion and V-C 13 (a nematicide) gave excellent results. In 1957, DDT, Dylox, Thimet, C&C 8305, V-C 13, Thiodan, toxaphene, endrin, and aldrin were evaluated. The significant result of the 1957 test was the failure of DDT to control the chinch bug. Thimet, diazinon, and Dylox gave satisfactory control. As a result of these tests, diazinon, V-C 13, and parathion were listed as materials that provided satisfactory control.

Kindler, S.D., K.P. Pruess, and S.M. Spomer. 1982. Granular application of phorate granules for control of chinch bugs on winter wheat. Insecticide and Acaricide Tests 7:198.

Phorate granules were applied with a tractor-powered drop spreader to a field infested with chinch bug *Blissus leucopterus leucopterus* (Say). Pre- and posttreatment chinch bug counts were made separately by three people and expressed as bugs/0.3 m of row. The chinch bug numbers did not differ significantly between treatments. A 3-cm rainfall 4 days posttreatment reduced the bug population by 96.5 percent. The rainfall apparently activated the phorate granules, which brought about a huge reduction in chinch bug population.

Kindler, S.D., R. Staples, and L.R. Cobia. 1982. Foliar applications of insecticides for control of chinch bugs on grain sorghum. Insecticide and Acaricide Tests 7:177.

Tests done with granular insecticides by these writers were reported earlier. In this study, they used foliar application of chemicals to control chinch bugs. In the first test, sorghum plants were sprayed and the chinch bugs were counted 1 and 3 days posttreatment on 10 plants in each plot. In the second test, sorghum plants were sprayed, bugs were counted 12 hr and 2 days posttreatment on 5 plants per plot. In another test, 3-4 plants were caged, 1,000 bugs were released

in each cage, and bugs were counted 12 hr and 5 days posttreatment. There were no pronounced differences among the treatments and the check in tests one and two. In test three, Furadan and Sevin treatments gave satisfactory control.

Kindler, S.D., R. Staples, and L.R. Cobia. 1982. Planting time applications of insecticides for control of chinch bugs on grain sorghum. Insecticide and Acaricide Tests 7:177-178.

Tests were conducted to determine the effect of granular insecticides at planting time on the infestation level of chinch bugs *Blissus leucopterus leucopterus* (Say). Insecticides were applied either in a furrow below the seed or in a 6-inch band in front of the planter press wheel. Six insecticides were used in the first test and two in the second test. A spray treatment of Baygon was included in the first test. Chinch bug numbers and plant survival were recorded at an interval of 1 mo. Only Furadan granules at the recommended dosage of 10 lb active ingredient/acre provided good control of bugs migrating into sorghum fields from adjacent wheat fields.

Krueger, S.R., J.R. Nechols, and W.A. Ramoska. 1991. Infection of chinch bug, *Blissus leucopterus* (Hemiptera: Lygaeidae) adults from *Beauveria bassiana* (Deuteromycotina: Hyphomycetes) conidia in soil under controlled temperature and moisture conditions. Journal of Invertebrate Pathology 58:19-26.

The fungal pathogen *Beauveria bassiana* is the major natural enemy of the chinch bug *Blissus leucopterus leucopterus* (Say). *Beauveria bassiana* propagules are found in little bluestem and in the soil and are associated with infection in the chinch bug. An attempt was made to determine if the conidia in the soil could produce infections in the chinch bug under controlled temperature and moisture conditions. Soil devoid of the pathogen was collected from the field and inoculated with viable conidia. By serial dilution of soil, three different concentrations of conidia were obtained. Chinch bugs were confined in this medium and fed an artificial diet. A 14:10 photophase was provided. Conidiogenesis was investigated at 22 °C.

A larger percentage of chinch bugs was infected when the concentration of conidia in the soil was high. At 30 °C, higher numbers of chinch bugs were infected under dry soil conditions. Soil moisture content in excess of 30 percent moisture-holding capacity was detrimental to inoculum longevity at both temperatures.

Kuitert, L.C., and G.C. Nutter. 1952. Chinch bug control and subsequent renovation of St. Augustine lawns. Florida Agricultural Experiment Station Circular S-50, 10 pp.

Chinch bugs damage St. Augustine grass by sucking plant juices, which causes yellowing of the plants in patches. When patches become noticeable, remedial measures should be enforced promptly to prevent the bugs from spreading. The bugs are highly migratory, and one application of insecticide is insufficient to eliminate infestation. Even though the symptoms of damage appear only in patches, the entire lawn should be treated to obtain satisfactory results. Lawns must be watered thoroughly before applying insecticides, but insecticides should be applied only after the foliage is dry.

On thin turf, 5 percent dusts of chlordane and DDT provide good control. On thick turf, sprays of DDT and chlordane are used. This treatment should be followed by a second treatment after 7-10 days. In cases where the grass has been thinned, immediate fertilization, coupled with good lawn management practices, can restore the lawn. Information about replanting with St. Augustine grass and growing other grasses instead of St. Augustine grass is discussed.

Lamp, W.O., and T.O. Holtzer. 1980. Distribution of overwintering chinch bugs, *Blissus leucopterus leucopterus* (Hemiptera: Lygaeidae). Journal of the Kansas Entomological Society 53:320-324.

It is a well-known fact that chinch bugs overwinter in bunchgrasses. There are no quantitative data on the relative importance of various overwintering sites. The authors attempted to relate bunchgrass characteristics and burn history to chinch bug abundance. Different bunchgrasses were dug after snowmelt and returned to the laboratory. Chinch bugs were extracted using a Berlese funnel. Grass characteristics, such as diameter of the bunch, stem height, and number of flowering stems in a bunch, were recorded. Little bluestem and big bluestem had more chinch bugs than switch grass did. Aboveground biomass was positively correlated with chinch bug abundance. Chinch bug numbers increased with the compactness of the grass species. Burn history did not affect insect abundance.

Laurence, G.A. 1971. Chinch bug control in lawns. Agricultural Society of Trinidad and Tobago Journal 71:72.

The chinch bug *Blissus leucopterus leucopterus* (Say) is considered to be as important a lawn pest in Trinidad as the West Indian mole cricket *Scapteriscus vicinus* Scudder is. Chinch bug control with

insecticides depends on the thickness of the lawn. Most insecticides give satisfactory control on thin lawns, but on thicker lawns, effective control is obtained only with parathion, diazinon, arprocarb, and carbophenothion. Parathion is very toxic, and the writer warns inexperienced people not to apply the chemical themselves. Trade names for the various chemicals used for chinch bug control are furnished.

Leonard, D.E. 1966. Biosystematics of the "Leucopterus complex" of the genus *Blissus* (Heteroptera: Lygaeidae). Bulletin of the Connecticut Agricultural Experiment Station 677, 47 pp.

The Leucopterus complex contains *Blissus leucopterus leucopterus* (Say), *B. leucopterus hirtus* Barber, *B. arenarius arenarius* Barber, *B. arenarius maritimus* Leonard, and *Blissus insularis* Montandan. Information on the life history, hosts, parasites, predators, diseases, distribution, and cytogenetics of the complex is presented. Most of the biological information on the better-known, economically important chinch bugs is presented, as well as and virtually all known biological information about the lesser-known species.

Leonard, D.E. 1968. A revision of the genus *Blissus* (Heteroptera: Lygaeidae) in eastern North America. Annals of the Entomological Society of America 61:239-250.

A lengthy biosystematic study on the Leucopterus complex was published in 1966. This paper follows that earlier publication and incorporates most of its conclusions. The present study was undertaken because the genus *Blissus* was taxonomically less understood, and a clarification of the various species was necessary. The lygaeid genus *Blissus* has many species, which include *Blissus leucopterus leucopterus (Say), B. l. hirtus, B. insularis, B. arenarius arenarius, B. iowensis, B. barberi, B. minutus,* and *B. nanus*. *Blissu validus* is synonymous with *B. l. leucopterus (Say)*. This paper provides keys for the adults of all the species listed and to nymphs of the Leucopterus complex. Other species described include *B. sweeti* and *B. breviusculus*.

Leonard, D.E. 1968. Three new species of *Blissus* from Antilles. Proceedings of the Entomological Society of Washington 70:150-153.

This paper describes three new species from Puerto Rico—*Blissus slateri, B. planus,* and *B. antillus*. The first two species are included in the Leucopterus complex.

Leonard, D.E. 1970. A new North American species of *Blissus* (Heteroptera: Lygaeidae). The Canadian Entomologist 102:1531-1533.

The identification is reported of a new species of *Blissus,* namely, *Blissus canadensis* from Saskatchewan, Alberta, and Montana. This species closely resembles *B. occiduus* Barber but is slightly longer, with longer antenna and labium and larger eyes. It is grouped with *B. iowensis* Andre, *B. breviusculus* Barber, and *B. barberi* Leonard. There is a possibility that *B. canadensis* might be univoltine. The native host of *B. canadensis* had yet to be determined when this article was published.

Liu, H.J., and F.L. McEwen. 1977. *Nosema blissi* (Microsporida: Nosematidae), a pathogen of the chinch bug, *Blissus leucopterus hirtus* (Hemiptera: Lygaeidae). Journal of Invertebrate Pathology 29:141-146.

A protozoan parasite associated with the chinch bug *Blissus leucopterus hirtus* Montandon is described for the first time. Three out of 746 adults were found to have the microsporidian *Nosema* lodged in their malpighian tubules. The name *Nosema blissi* was proposed for this new species.

Liu, H.J., and F.L. McEwen. 1977. The use of temperature accumulations and sequential sampling in predicting damaging populations of *Blissus leucopterus hirtus*. Environmental Entomology 8:512-515.

There is a need to develop a system that will rapidly classify infestations of the hairy chinch bug with respect to their damage potential. When such a system is combined with optimum timing of control measures, pesticide usage can be drastically reduced. A study was undertaken to develop a control system that can be put into practice. A temperature threshold of 7 °C was established for the initiation of postdiapause development; oogenesis marked this point. Based on a knowledge of day degrees accumulated above this threshold and their relationship to the peak in number of third-instar nymphs, sequential sampling and chemical applications were synchronized.

Sequential sampling helped to identify injurious infestations of *B. leucopterus hirtus* and to recommend control measures. The third instar conformed to a negative binomial distribution. The success of the scheme depended on correctly predicting the likelihood of damage; the system worked well on 35 lawns in Guelph, Ontario. The use of accumulated day degrees to time sampling and chemical

application eliminated laborious examination of lawns to determine when the third-instar population would peak.

Lugger, O. 1894. The chinch bug. Bulletin of the Agricultural Experiment Station, University of Minnesota 37:154-182.

The habits of the chinch bug are described at length, and remedies are suggested. The author believes that distribution of packages of the fungal parasite is well intended but disapproves of sensational articles which lead farmers to believe that the disease can be introduced without labor. He reiterates the necessity for more labor and care if farmers wish to accrue benefits from use of the micro-organism.

Luginbill, P. 1922. Bionomics of the chinch bug. U.S. Department of Agriculture No. 1016, 14 pp.

This bulletin describes the seasonal history and biology of the chinch bug in South Carolina. Illustrations and an explanation of the morphological differences between adult males and females are provided. The pest has two generations in this State. Adults hibernate among old, dead cornstalks, especially under leaf sheaths and their husks. In the spring, they fly to grain fields. Adult chinch bugs feign death when disturbed. Mating takes place repeatedly and may occur at intervals of 5-8 days. Females lay eggs at the base of plants, on roots, and in crevices in the field. The nymphs pass through five instars. The life cycle in South Carolina is not different from that in any other state.

Lynch, R.E., S. Some, I. Dicko, H.D. Wells, and W.G. Monson. 1987. Chinch bug damage to Bermuda grass. Journal of Entomological Science 22:153-158.

It has been known for a long time that bermudagrass is a host plant of the chinch bug *Blissus leucopterus leucopterus* (Say) but little work, if any, has been done to characterize the damage the bug does to this grass. Studies were conducted to (1) determine damage to bermudagrass, (2) evaluate the susceptibility of various bermudagrass clones to the chinch bug, and (3) determine the preference of the chinch bug for other grasses. Grasses such as goosegrass, Texas Panicum, crowfoot grass, pigweed, and sicklepod were found in the bermudagrass experimental pastures. The most preferred grass was goosegrass, followed by Texas Panicum, bermudagrass, crowfoot grass, pigweed, and sicklepod in that order.

Preference tests in the laboratory also showed that goosegrass served as a better host than bermudagrass. Six bermudagrass varieties were assayed for their resistance to the chinch bug. Kenya 61 was the most susceptible, and Tifton 292 was the most resistant.

MacLeod, G.F., and K.E. Maxwell. 1937. Experiments to control hairy chinch bug infesting turf on Long Island. Journal of Economic Entomology 30:432-437.

Many chemicals and natural products have been used to control the hairy chinch bug since the late 1800's. Tobacco dust, nicotine soap, soap, calcium cyanide, and kerosene emulsion are some of the compounds. This paper discusses studies that evaluate the effectiveness of these materials in controlling first- and second-brood chinch bugs, as well as some new compounds such as rotenone dust and tobacco dust. Tobacco dust (1 percent nicotine), cube dust (1 percent rotenone), and a spray of 40 percent nicotine sulfate with 40 percent pot oleate soap effected a high mortality among first-brood bugs. Tobacco dust, the most cost-effective substance, was also effective against the second-brood bugs. Information is presented on the susceptibility of grasses such as velvet bent, German mixed bent, Kentucky bluegrass, and Chewing's New Zealand fescue.

Mailloux, G., and H.T. Streu. 1979. A sampling technique for estimating hairy chinch bug (*Blissus leucopterus hirtus* Montandon: Hemiptera: Lygaeidae) populations and other arthropods from turfgrass. Annals of the Entomological Society of Quebec 24:139-143.

The authors identified the need for a good sampling technique for eggs and nymphs to study the population dynamics of the hairy chinch bug. A steel cylinder, 40 cm long and 17.2 cm in diameter, was driven into the soil. Insects in the turfgrass were forceably washed into the cylinder by high-pressure streams of water. The material collected on a 100-mesh sieve was put in plastic bags and taken to the laboratory. Ethanol (40 percent) was added to the material and centrifuged at 2,500 rpm for 5 min to extract insects. The sediment in which the insects were buried was washed with water. Sucrose solution (1.2 specific gravity) was added to this and centrifuged for 5 min at 2,500 rpm. Insects started to float as a result of this treatment, and they were then collected and counted. For egg extraction, the procedure was slightly modified by incorporating a blending step. Extraction of eggs ranged from 95 percent to 100 percent.

Mailloux, G., and H.T. Streu. 1981. Population biology of the hairy chinch bug (*Blissus leucopterus hirtus* Montandon: Hemiptera: Lygaeidae). Annals of the Entomological Society of Quebec 26:51-90.

An understanding of the population dynamics of a pest should always precede attempts to control it. In the case of the hairy chinch bug, indiscriminate spraying of chlordane resulted in an increase in the pest population in treated areas compared to untreated areas. A study was undertaken to unravel the life history of the hairy chinch bug to determine the number of generations, duration of a generation, adult longevity, and migration. Six mortality factors were identified: (1) parasitism by the scelionid, (2) infection by the fungus, (3) desiccation, (4) failure to hatch, (5) predation by an *Amara* sp., and (6) wet conditions that prevail during eclosion. Egg mortality was the most severe single-stage mortality at 59 percent. There were only two generations per yr, five nymphal instars were observed, and a temperature of 70 °F triggered activity in the winter quarters.

Mailloux, G., and H.T. Streu. 1982. Spacial distribution pattern of hairy chinch bug (*Blissus leucopterus hirtus* Montandon: Hemiptera: Lygaeidae) populations in turfgrass. Annals of the Entomological Society of Quebec 27:111-131.

This is the first paper published on the spatial distribution of the hairy chinch bug in a New Jersey lawn. Components of distribution were determined. Distribution patterns were fitted by several contagious, discrete statistical models. Various transformations were used, but none were successful in stabilizing the variance.

Mathias, J.K., R.H. Ratcliffe, and J.L. Hellman. 1990. Association of an endophytic fungus in perennial ryegrass and resistance to the hairy chinch bug (Hemiptera: Lygaeidae). Journal of Economic Entomology 83:1640-1646.

The fungal endophyte *Acremonium lolii* Latch, Christensen and Samuels (Clavicipitaceae: Belansiae) has been reported to be associated with insect resistance in perennial ryegrass *Lolium perenne* L. A study was undertaken to determine the effect of the endophyte on chinch bug development, survival, fecundity, and host preference. The endophyte-infected ryegrass cultivar Repell was compared with Repell that was not infected. Survival of first-instar, third-instar, and adult bugs was significantly higher on endophyte-free ryegrass than on endophyte-infected ryegrass. The development of young bugs was impaired because of the endophyte. The leaf blades of the endo-

phyte-infected ryegrass did not contain the fungus, and this is where most adults and nymphs resided. On an endophyte-free plant, the insects were found within the leaf sheaths. In choice tests, nymphs always preferred plants without the endophyte. Fecundity was higher on infected plants on days 7 and 14 and on uninfected plants on days 11, 18, and 21.

Maxwell, K.E., and G.F. Macleod. 1936. Experimental studies of the hairy chinch bug. Journal of Economic Entomology 29:339-343.

Information on the status of the hairy chinch bug as a pest, its injury to turf, its life history, and some experiments on its control on Long Island are presented. The earliest symptom of chinch bug feeding is browning of the grass, usually in spots that closely resemble sun scald. Heavy infestation leads to plant mortality. There were two distinct generations of bugs on Long Island. Work with different grasses and varieties of grasses indicated differences among the varieties in their reaction to chinch bug injury. Infection of the chinch bugs by the fungus *Sporotrichium globuliferum* was quite common. In tests with insecticidal compounds, tobacco dust, rotenone dust, and nicotine soap sprays gave the most promising results.

McColloch, J.W. 1913. A parasite of the chinch bug egg. The Canadian Entomologist 45:342-343.

While conducting experiments on the emergence of first-instar nymphs from eggs, the author found some of the eggs turned dark instead of assuming the normal red color. These eggs were isolated for close scrutiny. Three parasites emerged from the eggs. Following this, 275 individual parasites were reared. The length of the life cycle varied from 10 to 18 days. The parasites were sent for identification and were found to belong to the family Proctotrypidae, Hymenoptera.

McColloch, J.W. 1915. A new parasite of the chinch bug egg. Entomological News 26:147-149.

The life history of the chinch bug parasite *Eumicrosoma benefica* Gahan was investigated in 1914. Thousands of chinch bug eggs were collected from the field and the percentage with parasites was determined. Eggs were separated into groups and kept in vials. Close examination of the vials showed that one contained eggs with small, round holes cut in their sides. These holes were entirely different from those cut by either the chinch bug or the parasite *E. benefica*. Further studies indicated the presence of a new parasite that was later identified as *Abella subflava*.

McColloch, J.W. 1921. A method for studying the Hessian fly and other insects. Annals of the Entomological Society of America 14:227-230.

The Hessian fly larva often develops between the leaf sheath and stalk below the ground, so it is difficult to follow its growth. An attempt was made to grow wheat plants in an artificial medium so the entire plant would be exposed. Wheat plants were first grown in soil until they were 2-3 inches high, then transferred to 200-cm^3 wide-mouthed bottles containing 150 cm^3 water culture. The culture contained calcium nitrate, potassium nitrate, magnesium sulfate, potassium dihydrogen phosphate, potassium chloride, ferric chloride, and distilled water. Plants grew well in this solution. Corn, rye, oats, barley, and many sorghums were grown this way for chinch bug studies.

McColloch, J.W., and H. Yuasa. 1914. A parasite of the chinch bug egg. Journal of Economic Entomology 7:219-227.

A chinch bug parasite was collected during previous studies on the early emergence of first-instar nymphs from eggs. The parasite was identified as *Eumicrosoma benefica* Gahan. The ova have been examined many times, and not more than 30 ova have been found in a female. The eggs of the parasite have never been observed once they are laid into chinch bug eggs; so the duration of the egg stage has been difficult to determine. Based on the identification of the hatched larva, the egg period has been predicted to range from 2 days to about a week. The larval duration varies from 5 to 15 days based on climatic conditions. The adult cuts a zigzag opening around three-fourths of the anterior end of the egg by rasping and tearing with the mandibles. The number of females greatly exceeds the number of males. Parthenogenesis is also observed in this parasite.

McColloch, J.W., and H. Yuasa. 1915. Further data on the life economy of the chinch bug egg parasite. Journal of Economic Entomology 8:248-261.

This work is a continuation of the one described above. Information on the history and distribution of *Eumicrosoma benefica* Gahan is furnished, along with a description of the various stages of the parasite, relationship and economy of the sexes, and host relationships. Other details include the effects of temperature, light, and contact on the behavior of the insect. A low temperature of 40-50 °F prolongs the life cycle from 16 to 42 days. Parasites exposed to

temperatures above 100 °F for 3-4 hr die. Adults exhibit negative phototropism and positive thigmotropism.

Meehan, M., and G. Wilde. 1989. Screening for sorghum line and hybrid resistance to chinch bug (Hemiptera: Lygaeidae) in the greenhouse and growth chamber. Journal of Economic Entomology 82:616-620.

The use of resistant varieties has long been recognized to be a very effective control measure against the chinch bug *Blissus leucopterus leucopterus* (Say). Sorghum lines and hybrids were screened in the growth chamber and in the greenhouse using choice and no-choice tests. The photoperiods and temperatures used were 16:8 hr (light:dark) and 21-32 °C respectively, in the greenhouse and 16:8 hr (light:dark) and 24-30 °C, respectively, in the growth chamber. Choice tests were conducted separately for nymphs and adults, multiple choice tests were done for adults, and tests in the greenhouse were compared with those in the growth chamber. In the nymphal choice tests, PAG 4433 suffered more damage at 8, 10, 12, and 14 days after infestation compared to O's Gold GS 712. The hybrid KS 72 was more resistant than KS 91 or Wheatland. In adult choice tests, Funk G 1642 fared better than O's Gold GS 712. There were a total of 29 comparisons involving hybrids and lines, and only 5 differed significantly from others in the growth chamber but not in the greenhouse. Screening for resistance can be done either in the greenhouse or in the growth chamber.

Merkle, O.G., K.J. Starks, and A.J. Casady. 1983. Registration of pearl millet germplasm lines with chinch bug resistance. Crop Science 23:601.

This reports the registration of five pearl millet lines resistant to the chinch bug *Blissus leucopterus leucopterus* (Say) and three susceptible lines released for the purpose of comparison by the Oklahoma Agricultural Experiment Station and the USDA Agricultural Research Service. The experimental designations of the lines were PM 23 BIR (GP 16), PM 50 BIR (GP 17), PM 96 BIR (GP 18), PM 122 BIR (GP 19), PM 151 BIR (GP 20), PM 7 BIR (GP 21), PM 77 BIR (GP 22), and PM 114 BIR (GP 25).

Metcalf, C.L., W.P. Flint, and R.L. Metcalf. 1962. Destructive and Useful Insects. McGraw-Hill Book Co., New York, 1,036 pp.

Some basic information on the chinch bug *Blissus leucopterus leucopterus* (Say) is presented. The authors describe this destructive

pest with respect to its appearance, distribution, life history, and hosts.

Miller, B.W.O. 1971. Recent developments with Dursban insecticide for chinch bug control. Down to Earth 27 (3):1-5.

The insecticide Dursban 2E was registered for southern chinch bug control in 1966. It was applied in combination with granular insecticides. Dursban M and Dursban MC were impregnated with granular insecticides and when used for chinch bug control, provided satisfactory results. Additional trials were conducted to determine if the recommended quantity of active ingredient could be used with lower volumes of spray fluid. Results indicated that a spray fluid volume as low as 7.5 gal/acre, followed by sprinkling the field with 1 acre-inch of water, produced very good control. Dursban did not produce phytotoxic effects.

Mize, T.W. 1980. Chinch bug *Blissus leucopterus leucopterus* (Say) screening of grain sorghum germplasm for resistance and evaluation of insecticides at planting time for control. Kansas State University, Manhattan. M.S. thesis.

Investigations were undertaken to identify improved levels of resistance to the chinch bug in grain sorghum and to investigate the efficacy of systemic soil insecticides applied at planting for the control of chinch bugs at planting time. Screening tests indicated that levels of chinch bug resistance did exist in many sources of sorghum previously unavailable for resistance evaluations. Kafir-based hybrids were found to be more resistant than milo-based hybrids. The greenhouse screening techniques provided a good way to sort for resistance. Six chemicals were tested for their effectiveness against the pest. Carbofuran and terbufos provided satisfactory results during both study yr. Residual control did not exceed 30 days, which suggested that if migrations were to occur 30 days after planting, treatment at planting would be ineffective. In-furrow treatment of carbofuran, terbufos, bendiocarb, and acephate and seed treatments of carbofuran gave good initial control. Band treatments of these chemicals were ineffective without rainfall.

Mize, T.W. 1985. Components of resistance to the chinch bug *Blissus leucopterus leucopterus* (Say) in new sorghum resistance sources. Kansas State University, Manhattan. Ph.D. dissertation.

Studies were conducted to determine the components of resistance to the chinch bug in new sorghum sources. The presence and degree

of antibiosis, antixenosis, and tolerance were investigated. Many new sources exhibited reasonably high levels of antibiosis in the seedling stage. Seedling antibiosis was equal to or greater than that of the resistant check Atlas. Antibiosis resulted in reduced fecundity, affected developmental rates, increased nymphal mortality, and decreased adult size. Antixenosis tests suggested that many new lines were less preferred than Atlas. Tolerance was also exhibited by some lines.

Mize, T.W., and G. Wilde. 1986. New grain sorghum sources of antibiosis to the chinch bug (Heteroptera: Lygaeidae). Journal of Economic Entomology 79:176-180.

Many researchers have shown that resistance in sorghum to the common chinch bug is due to tolerance or antixenosis. It has not been demonstrated conclusively whether antibiosis is also a component of chinch bug resistance in sorghum. Some new sorghum lines were screened for the presence of antibiosis. The lines used were the same as those used in the test described in the previous work. Atlas was used as the resistant check. Nymphs were maintained on 10-day-old plants at all times. Data on nymphal mortality were collected. Antibiosis tests were also conducted in the field using caged plants. Some of the new lines exhibited comparable or higher levels of antibiosis than Atlas. The presence of additive gene action could allow the incorporation of many resistant sources and mechanisms that enhance the level of antibiosis.

Mize, T.W., and G. Wilde. 1986. New resistant germplasm to the chinch bug (Heteroptera: Lygaeidae) in grain sorghum: contribution of tolerance and antixenosis as resistant mechanisms. Journal of Economic Entomology 79:42-45.

The modalities of resistance to the chinch bug *Blissus leucopterus leucopterus* (Say) in sorghum have not been studied in detail. Earlier workers thought that resistance was due purely to tolerance because heterosis played a big role in the expression of resistance. Then antixenosis was identified as another component of resistance in grain sorghum. This study investigated the possible contribution of antixenosis and tolerance to resistance in some new germplasm lines. Four of the six lines used in antixenosis and tolerance tests were new resistance sources identified in the field and in the greenhouse as having chinch bug resistance. Along with these lines, Wheatland was used as a susceptible check and Atlas as a resistant

check. The new resistant sources were found to have higher levels of antixenosis and tolerance, even when compared with Atlas. BCK 60-1155 was less affected by chinch bug feeding than Atlas was. Plant vigor played an important role in contributing to tolerance in the early stages, but after about 10 days of feeding, significant plant death occurred in all resistant sources except BCK 60-1155.

Mize, T.W., and G. Wilde. 1986. Reproduction of the chinch bug (Heteroptera: Lygaeidae) on new resistance sources in grain sorghum. Journal of Economic Entomology 79:664-667.

Sorghum lines with putative antibiosis, antixenosis, and tolerance characteristics against the chinch bug *Blissus leucopterus leucopterus* (Say) were identified. An attempt was made to use chinch bug fecundity as a tool in screening sorghum germplasm for resistance. Three different tests were done to determine the effect of sorghum lines on total fecundity, partial fecundity, and adult longevity on seedlings and older plants. Wheatland and DDYM were used as susceptible checks and Atlas and Combine Kafir 60 were used as resistant checks. An average of 247.8 eggs was laid on DDYM, compared to 101.2 eggs laid on Atlas over a 6-mo period. Mean female longevity was substantially lower in many of the test lines, compared with longevity on DDYM. Reproduction on new germplasm sources was not significantly different; egg viability and female longevity did not seem to be affected by genotype. Fecundity on BCK 60-1155, 1155, and SC 503 was substantially lower than it was in the checks and on sorghum lines that were already identified as being resistant to the pest. Levels of antibiosis observed in many of the test lines appeared to be sufficient to reduce the pest population by affecting reproduction.

Mize, T.W., G. Wilde, and M.T. Smith. 1980. Chemical control of chinch bug and greenbug on seedling sorghum with seed, soil and foliar treatments. Journal of Economic Entomology 73:544-547.

A total of eight chemicals were evaluated for their effectiveness against the chinch bugs in trials conducted over 2 yr (1978-79). Various formulations of carbaryl, acephate, and Penn Cap E were used along with chlorpyrifos, carbofuran, pydrin, pymethrin, and endrin. Foliar insecticides were tested under varying conditions of plant height, insect numbers, and location of the insect in the plant. Initial and residual effectiveness of granular insecticides were determined. The liquid formulations were used in seed treatments and soil treatments (in furrow and band). Formulations of carbofuran

and carbaryl were equally effective as foliar sprays. Residual activity up to 30 days after planting was observed in the case of carbofuran. Band treatment of carbofuran combined with rainfall was very effective in controlling the pest.

Morishita, F.S., R.N. Jefferson, and L. Johnston. 1969. Southern chinch bug: a new pest of St. Augustine grass in southern California. California Turfgrass Culture 19(2):9-10.

The southern chinch bug *Blissus insularis* Barber was first found to damage St. Augustine grass in 1967 near Whittier, Los Angeles County. It started to spread all over southern California in the next couple of yr. The bugs injure the grass by desapping it, which makes it wilt and die. This insect has two adult forms, the long winged and the short winged. Studies indicated there were two generations of this pest each yr. Chemicals used for control include Akton, Aspon, Baygon, and Dursban.

Morrow, G.E. 1896. Methods of destroying chinch bugs. Bulletin of the Oklahoma Agricultural Experiment Station 19, 8 pp.

This bulletin discusses some methods to reduce damage caused by the chinch bugs. Techniques described include the use of the white fungus *Sporotrichium globuliferum*, barriers and traps to restrict migration of the bugs, and kerosene emulsion to reduce chinch bug populations as much as possible.

Negron, J.F., and T.J. Riley. 1985. Effect of chinch bug (Heteroptera: Lygaeidae) feeding in seedling field corn. Journal of Economic Entomology 78:1370-1372.

The chinch bugs are sap feeders that damage plants by sucking plant juices from the base of the stem and from the roots. Feeding results in plant wilting, stunting, and even death. The degree of damage depends on the plant stage and the number of bugs on a single plant. Damage to corn was determined at three stages of plant development. Experiments were done in the greenhouse under controlled conditions of 32 $\pm$ 2 °C, 60 $\pm$10 percent relative humidity and a 14:10 hr (light:dark) photoperiod. Pioneer Brand 3369 A seedlings were infested with 0, 2, 5, 10, 15, and 20 field-collected adult chinch bugs. The plant development stages used were V1, V2, and V2.5. The results obtained suggested that damage to corn was strongly influenced by the stage of plant growth. Just two insects were sufficient to reduce plant height in V1 plants. At infestation levels of 10, 15, and 20 insects, V2 and V2.5 plants exhibited significant height reductions.

Negron, J.F., and T.J. Riley. 1990. Long-term effects of chinch bug (Hemiptera: Lygaeidae) feeding on corn. Journal of Economic Entomology 83:618-620.

It was demonstrated that young corn plants are more susceptible to chinch bug injury than older plants. Field trials were conducted to determine recovery of corn plants under varying degrees of artificial and natural infestation of the chinch bug. The plants tested were in the V2 and V5 stages and the levels of infestation were set at 0, 2, 5, 10, 15, and 20 adults per plant. Plants damaged by naturally occurring populations were rated as showing no damage, slight damage, moderate damage, and heavy damage. These plants were allowed to mature. Plants that were infested at stage V2 were damaged the most, as reflected by a reduction in ear weight and length. Under natural infestation, yield characteristics decreased as the damage rating increased.

Negron, J.F., and T.J. Riley. 1991. Seasonal migration and overwintering of the chinch bug (Hemiptera: Lygaeidae) in Louisiana. Journal of Economic Entomology 84:1681-1685.

Much information is available on the overwintering biology and migration of the chinch bug *Blissus leucopterus leucopterus* (Say) in the Midwest. Not much work has been done on the timing of spring and fall migration in the South, especially in Louisiana. This paper provides information on work done on the overwintering biology and seasonal migration of this pest in Louisiana. Migration was monitored using pitfall and flight traps. Studies demonstrated that the chinch bugs come out of their winter quarters in April. Temperature was found to influence large-scale emergence. Overwintering biology was studied by sampling bunchgrasses in winter to determine the number and condition of the bugs. Large populations were found in *Andropogan virginicus* in November and December. The population started to decrease in bunchgrasses in January and continued until the bugs emerged in April.

Oliver, A.D., and K.N. Komblas. 1968. Controlling chinch bugs in St. Augustine grass (*Blissus insularis*). Louisiana Agriculture 11:3,16.

The southern chinch bug *Blissus insularis* Barber injures St. Augustine grass by desapping the plants. Feeding leads to wilting and death, which causes irregular patches of brown in the lawn. Because of the extensive damage to this grass, there have been reports of homeowners switching to other grasses such as zoysia grass, bermudagrass, and centipede grass, which are relatively less injured

by the insect. Two to three applications of insecticides offered sustained control of this pest in most lawns in Louisiana. Insecticides recommended for use in lawns include diazinon, ethion, VC-13, Trithion, Dursban, Akton, Aspon, and Sevin.

Osborn, H. 1888. The chinch bug (*Blissus leucopterus* Say). Iowa State Agricultural College Report 1888:670-671.

In 1887, the loss attributed to chinch bugs in Iowa was estimated at $20 million. In 1888, the loss was much lower because spring wheat and barley experienced less damage. A reduction in the pest's numbers in 1888 was attributed to an extended period of rain in late spring. In August, the parasitic fungus *Entomophthora* sp. destroyed myriad bugs in Iowa, Illinois, and Minnesota. The writer reiterates "the necessity of vigilant warfare upon the insects wherever they are found unless they are infected by the fungus." Growing nonhost crops is also suggested.

Packard, C.M., and C. Benton. 1937. How to fight the chinch bug. U.S. Department of Agriculture Farmers Bulletin 1780, 22 pp.

The chinch bug *Blissus leucopterus leucopterus* (Say) is one of the most destructive native pests of grain and grass crops in the United States. This bulletin presents basic information on the chinch bug, including its distribution, occurrence, importance, biology, seasonal history, host and nonhost plants, natural enemies, and remedial measures. It is understood that the few natural enemies are not sufficient to prevent the bug from injuring crops. Spraying and dusting are expensive control measures. The most effective and cheapest method of controlling this insect is to grow immune or resistant crops or crop mixtures. Farm practices can be modified to prevent infestation. The construction of barriers to prevent the bugs movement from small grains into corn is strongly recommended.

Packard, C.M., P. Luginbill, and C. Benton. 1951. How to fight the chinch bug. U.S. Department of Agriculture Farmers Bulletin 1780, 22 pp.

This is a revision of the bulletin cited previously. Most of the information included is taken from circulars no. 431 and no. 590 of the Illinois Agriculture Experiment Station.

Painter, R.H. 1928. Notes on the injury to plant cells by chinch bug feeding. Annals of the Entomological Society of America 21:232-242.

Chinch bugs damage plants by sucking their juices and causing them to wilt. This paper examines the method of puncturing, the

plant cells affected, the role of the stylets, and the injury done to the cells. Using hot Carnoy's fluid and hot paraffin, nymphs were fixed in place while their stylets were inside the plant tissue. The mouth parts of the chinch bug are similar to those of other Heteropterans. Most Heteropterans leave stylet tracks or stylet sheaths in the tissue when they withdraw the stylet. The stylet sheaths are made of callose, calcium pectate, and tannins.

Preliminary studies on stylet sheaths from chinch bugs indicated that they were similar to those made by other groups. The phloem, xylem, epidermis, mesophyl, sclerenchyma, protoxylem, and bundle parenchyma tissues are pierced. The bug's salivary fluid helps dissolve cell matter and aids in puncturing the plant cells. Mechanical injury to the pierced cells is low, compared to the injury caused when the bugs suck sap from the phloem or xylem. There are few differences between punctures made by adults and nymphs. While studying the feeding habits on different varieties, researchers suggested the presence of tannin was associated with resistance.

Painter, R.H. 1933. Chinch bugs and sorghums. Proceedings of the North Central Branch of the Entomological Society of America 12:44.

This paper contains descriptions of 10 slides showing resistant and susceptible sorghum varieties. Milos were susceptible, and Kansas Orange and kafirs were resistant. The paper contains information on chinch bug mouth parts and the type of injury caused on sorghum.

Painter, R.H. 1951. Insect Resistance in Crop Plants. MacMillan Company, New York, 520 pp.

The use of resistant varieties as an adjunct to barriers has yielded good results against the first-brood bugs. Growing resistant varieties of corn and sorghum has helped to alleviate the problem caused by second- and third-brood bugs. Also reported is some earlier work on the effect of fertilizers on chinch bug infestation, as well as studies on resistance and inheritance of resistance.

Painter, R.H., R.O. Snelling, and A.M. Brunson. 1935. Hybrid vigor and other factors in relation to chinch bug resistance in corn. Journal of Economic Entomology 28:1025-1030.

Corn is injured by first-brood immigrant bugs from wheat and by second-brood bugs that hatch in the corn field. A study was conducted to determine resistance in corn to first- and second-brood bugs and to ascertain the relationship between hybrid vigor and tolerance to chinch bug attack. A total of 50 inbred lines, hybrids,

and open-pollinated varieties were planted at Lawton, OK, and Manhattan, KS. Observations of yield, lodging, and grain quality were used as criteria to measure chinch bug damage.

Line B 164 showed less injury to first-brood injury than the popular Pride of Saline line. The reaction of hybrids was compared with that of the inbred parent lines. The hybrids were found to be much more tolerant than the parents. The writers felt the ability of hybrids to survive infestation was either because of inheritance of specific resistance to the chinch bug or tolerance to or escape from injury associated with hybrid vigor. A list of resistant hybrids and inbred lines is furnished.

Parker, J.R. 1911. The chinch bug in Montana. Journal of Economic Entomology 13:318-322.

The first occurrence of the chinch bug *Blissus leucopterus leucopterus* (Say) in Montana was in 1911. Basic information is given on the biology, seasonal history, migration, indications of nymphal hibernation, and host plants of the chinch bug in Montana.

Parker, J.H. 1931. Insect resistance in wheat and sorghum, a heritable character. U.S. Department of Agriculture Yearbook, pp. 316-317.

A novel method of performing chinch bug resistance studies is presented. To test for resistance in sorghums, plantings are made at one edge of a wheat field. The bugs move into sorghum after the wheat is harvested. The basis for chinch bug resistance in sorghum is not very clear, but milos are known to be highly susceptible. Feterita and some of the kafirs and sorgos are more resistant. Resistance in sorghum is a heritable character. Dwarf Yellow milo (susceptible) and Kansas Orange sorgo (resistant) were crossed, and hybrid selections much more resistant than the milo parents were developed. Experiments in wheat for Hessian fly resistance also are described.

Parker, F.W., and N.M. Randolph. 1972. Mass rearing the chinch bug in the laboratory. Journal of Economic Entomology 65:894-895.

A rearing technique for the chinch bug *Blissus leucopterus leucopterus* (Say) using corn or sorghum stalks is described. Plant stalks were arranged crosswise in a 1-gal ice cream carton by alternating layers of two sections to form an open center. The ends of the stalks were waterproofed using paraffin. Adult chinch bugs were placed in four stalk sections, and four more sections were subsequently added. Eggs were usually laid on the fringes of paraffin. Nymphs that

hatched from eggs laid on paraffin died, as they were unable to free themselves from the sticky material. Cheesecloth was provided for egg laying. Fungal attack was minimized by washing the stalk sections in warm soapy water or by treating them with a 1.0-percent solution of benzalkonium chloride.

Parks, T.H. 1940. Effect of wheat harvesting machinery on insect control. Journal of Economic Entomology 33:646-647.

This study on the impact of harvesting machinery on insect control in wheat concluded that the manner of harvesting had no apparent effect on the chinch bug *Blissus leucopterus leucopterus* (Say). Other insects studied were the Hessian fly, wheat stem sawfly, wheat straw worm, green bug, wheat midge, and the Augumois grain moth. Of the insects studied, nine were promoted by the combine, one was suppressed by it, and three were not affected by the machinery.

Peters, L.L. 1982. Susceptibility of chinch bugs to selected insecticides-laboratory study. Journal of the Kansas Entomological Society 55:317-322.

Twenty-four insecticides were tested in the laboratory for their efficiency in controlling the common chinch bug. Bugs were collected from overwintering sites and allowed to feed on wheat plants before they were exposed to insecticides. Insecticides were first diluted to 5 percent in acetone. Working solutions were prepared from this stock solution. Filter papers were dipped into each test solution, saturated, and air-dried for 30 min. Each test was replicated three times. Filter papers were placed in petri plates, a little water was added to remoisten the papers, and a 5-cm section of sorghum leaf was placed in each dish. Mortality of chinch bugs after 24 hr was recorded. Insects were also directly exposed to the insecticides in another study. LD_{95} for each chemical was calculated. Terbufos was the most potent chemical in the paper treatment method and carbophenothion was the least toxic. In the insect treatment method, permethrin was the most toxic chemical and toxaphene was the least toxic.

Peters, L.L. 1983. Chinch bug (Heteroptera: Lygaeidae) control with insecticides on wheat, field corn and grain sorghum. Journal of Economic Entomology 76:178-181.

Based on the tests described in the preceding article, chemicals were selected for testing in the field on wheat, corn, and sorghum. Phor-

ate, carbaryl, carbosulfan, and chlorpyrifos were used on wheat. Carbofuran, carbosulfan, chlorpyrifos, aldicarb, and terbufos were used at planting time on sorghum. Chlorpyrifos, phorate, carbaryl, carbofuran, and permethrin were used on corn against first-generation bugs. The efficacy of each insecticide was calculated based on insect counts. Phorate granules produced the best results in wheat. Carbofuran and carbosulfan sprays and granules at planting time in sorghum resulted in larger plant stands. Postemergence application of phorate granules and chlorpyrifos sprays in corn gave good control of the first-generation bugs. Postemergence application of carbofuran granules to corn provided 70.5 percent control in a week.

Peters, L.L. 1986. Chinch bug management. NebGuide, G86-806, 4 pp.

A brief description of the chinch bug *Blissus leucopterus leucopterus* (Say) is presented along with notes on its life cycle, plant injury, and methods to control the insect in corn and sorghum. Growing nonhost crops instead of sorghum, corn, or wheat is recommended in order to reduce chinch bug numbers. Also listed are some insecticides and methods of application for effective control of the pest.

Polivka, J.B. 1963. Control of hairy chinch bug, *Blissus leucopterus hirtus* Montandon, in Ohio. Ohio Agricultural Experiment Station Circular 7, 1 p.

The hairy chinch bug causes considerable damage to turfgrass. Chinch bug control experiments were conducted from 1960 to 1962 on private lawns and in a cemetery. Fifteen insecticides were tested for their effectiveness. All of the insecticides except Guthion, Kepone, and Zectran were effective in reducing the bug population of the first generation. Bayer 29493, carbophenothion, and Sevin were ineffective against second-generation bugs. Dylox gave fair results, whereas chinch bug killer toxicant provided good control of the first generation but not the second generation. Endosulfan failed to control bugs of either generation. In 1962, Sevin, ethion, chinch bug killer, ronnel, phorate, and DDT emulsifiable concentrate gave good control of both generations of the hairy chinch bug. Dimethoate and Bayer 39007 were sufficiently effective in controlling the pest to deserve a place in future control tests.

Polivka, B., and F. Irons. 1966. Experimental control of chinch bugs on corn. Journal of Economic Entomology 59:759.

Three insecticides—phorate, malathion, and dimethoate—were used for the control of *Blissus leucopterus leucopterus* (Say) in Wooster, OH,

in 1965. Phorate applied in granular form proved to be very effective. Malathion and dimethoate sprays were effective up to 2 days after spraying. It is suggested that these two chemicals be used in an emergency.

Prendergast, B. 1943. Observations on the sand dune chinch bug, *Blissus mixtus* Barber (Hemiptera: Lygaeidae). Pan-Pacific Entomology 19:59-60.

This species of *Blissus* was described in 1939 by Barber. *Blissus mixtus* is abundant in the sand dune areas along the Pacific coast of the San Francisco peninsula. The host plant is the beach grass *Ammophila arenarius*. The bugs live near the roots and among the stem sheaths. These adults, like those of the common chinch bug, feign death. The ratio of brachypterous to macropterous forms is equal in this insect. There is no hibernation or migration, and there are three generations each year.

Ramoska, W.A. 1984. The influence of relative humidity on *Beauveria bassiana* infectivity and replication in the chinch bug, *Blissus leucopterus*. Journal of Invertebrate Pathology 43:389-394.

Beauveria bassiana is a very important natural enemy of the chinch bug. The fungus has been known to perform well under high-moisture conditions. The pathogenicity of this fungus was tested under varying levels of relative humidity. Chinch bugs were exposed to fungal conidia at relative humidity levels of 0, 30, 50, 75, and 100 percent. The temperature was constantly maintained at 25 °C. Mortality of the chinch bug occurred at all the humidity ranges tested. The production of the characteristic white mycelial growths and conidia representing fungal replication and conidiogenesis, respectively, occurred only at relative humidities of $\geq$75 percent.

Ramoska, W.A., and T. Todd. 1985. Variation in efficacy and viability of *Beauveria bassiana* in the chinch bug (Hemiptera: Lygaeidae) as a result of feeding activity on selected host plants. Environmental Entomology 14:146-148.

This is a very important paper that reports the probable presence of a plant-produced fungal inhibitor in corn and sorghum. Chinch bugs were inoculated with dry *Beauveria bassiana* conidia, and the treated bugs were released on corn, wheat, sorghum, and barley and incubated alongside insects released into artificial diet. Treated bugs were incubated in an environmental chamber at 27 °C, 85 percent relative humidity, and a 16-hr photoperiod for 2 wk. Results indi-

cated that chinch bugs which fed on sorghum and corn were less susceptible to the pathogen. Conidial production was virtually nonexistent in cadavers taken from sorghum and corn. This demonstrated the presence of a fungistatic compound in corn and sorghum.

Randolph, N.M., and G.L. Teetes. 1971. Control of the chinch bug on grain sorghum. Texas Agricultural Experiment Station Progress Report 2875, pp. 32-34.

Granular and spray formulations of several insecticides were evaluated in Texas for control of the chinch bug *Blissus leucopterus leucopterus* (Say) on grain sorghum. Ten plants in each plot were sampled, and the total number of insects on the lower 8 inches of plants was recorded. Insecticides were sprayed or applied as sidedress. Insect counts were taken 2, 6, and 13 days posttreatment for sprays and at weekly intervals beginning 1 wk after treatment for granular insecticides. Most of the treatments reduced chinch bug numbers. Spray application of toxaphene, toxaphene + DDT + methyl parathion, and endosulfan + parathion gave good control throughout the study period. Temik, phorate, and Baygon applied as granules substantially reduced the bug population 28 days posttreatment. All materials had an effect up to 42 days following treatment.

Ratcliffe, R.H. 1982. Evaluation of cool season turfgrass for resistance to the hairy chinch bug. *In* H.D. Niemczk and B.J. Joyner, eds. Advances in Turfgrass Entomology, pp. 13-18. Hammer Graphics, Piqua, OH.

The hairy chinch bug *Blissus leucopterus hirtus* Montandan is a sporadic but serious pest of turfgrasses in the mid-Atlantic and northeastern states. Germplasm of a variety of grasses, such as Kentucky bluegrass, *Poa pratensis* L.; perennial ryegrass, *Lolium perenne* L.; tall fescue, *Festuca arundinacea* Schreber; and fine leaf fescues such as *Festuca rubra* L., *Festuca rubra* var. *commutata* Gaud, and *Festuca ovina* L., were screened for chinch bug resistance. Screening was done in the laboratory (in growth chambers maintained at 21-24 °C and a 14-hr photophase) and in the field. Separate tests were conducted for tolerance, antibiosis, and feeding nonpreference. In field tests, the plots were sampled for chinch bug numbers using the flotation technique.

The Kentucky bluegrass varieties Baron and Newport performed very well in tolerance tests. These two varieties were the only ones that were significantly more tolerant than Adelphi, the susceptible check. The antibiosis and antixenosis tests did not yield any significant results. In field tests, the perennial ryegrass varieties Manhat-

tan, Pennfine, and Score had significantly lower infestations of chinch bugs, with Score being the better of the three varieties.

Ratcliffe, R.H., and P.B. Baker. 1976. Selection for resistance to the chinch bug (*Blissus leucopterus hirtus*) in cool season grasses. Proceedings of Forage Insect Research Conference 18:26-27.

A large number of varieties and P.I.'s of Kentucky bluegrass, perennial ryegrass, and tall fescue were evaluated for tolerance, antibiosis, and feeding nonpreference. This paper furnishes information on how these tests were performed. Survival of the insects on the test lines ranged from 85 to 100 percent in most of the tests; the lines showed no signs of resistance. The method of screening described is also used to evaluate the influence of plant age on insect development and survival.

Reinert, J.A. 1972. Control of the southern chinch bug, *Blissus insularis*, in South Florida. The Florida Entomologist 55:231-235.

New materials were examined for their insecticidal activity against the chinch bug *Blissus insularis* Barber. A pretreatment count was taken using the flotation method. After insecticide application, five weekly counts were taken. Akton, propyl thiopyrophosphate, diazinon, chlorpyrifos, Dyfonate, ethion, and Nemacide gave satisfactory results.

Reinert, J.A. 1972. New distribution and host record for the parasitoid *Eumicrosoma benefica*. The Florida Entomologist 55:143-144.

The wasp *Eumicrosoma benefica* Gahan has been known to parasitize members of the genus *Blissus* since 1913. The wasp was first observed on *Blissus leucopterus leucopterus* (Say). This paper reports, for the first time, the presence of the parasitic wasp among populations of the southern chinch bug *Blissus insularis* Barber in Florida. A brief note on the host-seeking behavior of the insect is presented. A ratio of 34.5 wasps to 90.1 chinch bugs was observed. There were more male than female wasps in the study area.

Reinert, J.A. 1974. Control of the southern chinch bug and sod webworm in Florida turfgrass—effect of water rate and formulation of Dursban insecticide. Down to Earth 29(4):10-13.

Based on a series of studies, the University of Florida's Extension Service recommended Akton, Aspon, Baygon, diazinon, ethion, Trithion, and VC-13 insecticides to control the southern chinch bug. The tests described were conducted to increase the effectiveness and

to extend the period between applications of Dursban. The study was conducted in a St. Augustine grass lawn already infested by the chinch bug. Many formulations of Dursban were studied. This chemical provided a very satisfactory level of control in all of the tests. The rate of water in the spray and the use of irrigation before or after treatment did not have any effect on the innate residual toxicity of Dursban.

Reinert, J.A. 1974. Tropical sod webworm and southern chinch bug control in Florida. The Florida Entomologist 57:275-279.

Many insecticides were evaluated on two of the most destructive pests of turfgrass in Florida, the sod webworm and the southern chinch bug. For the chinch bug, pretreatment numbers were recorded by sampling St. Augustine grass using the flotation method. Nine insecticides were tested on the chinch bugs, using both granular and spray formulations. Application of carbofuran, Dyfonate, Mocap, PP-484, Primicid, and propyl thiopyrophosphate provided good control of the pest. These chemicals were also expected to have good residual activity if reinfestations occurred.

Reinert, J.A. 1978. Antibiosis to the southern chinch bug (*Blissus insularis*) by St. Augustinegrass (*Stenotaphrum secundatum*) accessions. Journal of Economic Entomology 71:21-24.

St. Augustine grass is heavily damaged by the southern chinch bug *Blissus insularis* Barber. Twenty-six accessions of this grass were screened in the laboratory for resistance to the chinch bug. Antibiosis tests were performed on the nymphs and adults. Floratam was the resistant check and the St. Augustine grass variety Common was the susceptible check. Varieties that exhibited antibiosis against the adults were used for tests on nymphs. The accessions Floratam, FA-46, FA-64, FA-73, FA-80, FA-87, FA-121, FA-131, FA-145, FA-217, and FA-243 produced significantly higher insect mortality in 4 to 7 days. Mortality on Floratam was much more pronounced than on any other selection. After 7 days, FA-46, FA-73, FA-87, FA-121, and FA-131 produced effects similar to that produced by Floratam. Floratam, FA-46, and FA-121 exhibited high levels of antibiosis. The resistant accessions were coarse textured and had long internodes.

Reinert, J.A. 1978. Natural enemy complex of the southern chinch bug (*Blissus insularis*), pest of St. Augustine grass (*Stenotaphrum secundatum*) in Florida. Annals of the Entomological Society of America 71:728-731.

This paper is the result of an 8-yr study and provides a list of parasites and predators of the chinch bug *Blissus insularis* Barber in

Florida. *Eumicrosoma benefica* Gahan was the only parasitoid encountered during the study period. The predators included *Pagasa pallipes* Stal. (Nabidae), *Geocoris uliginosus* (Say) and *G. bullatus* (Say) (Lygaeidae), *Xylocoris vicarius* (Reuter) and *Lasiochilus pallidulus* (Reuter) (Anthocoridae), *Sinea* sp. (Reduviidae), *Labidura riparia* Pallas (Dermaptera: Labiduridae), several ant species, and a spider *Lycosa* sp. The fungal pathogen *Beauveria bassiana* (Balsoma) Vuillemin was also observed.

Reinert, J.A. 1982. Carbamate and synthetic pyrethroid insecticides for control of organophosphate-resistant southern chinch bugs (Heteroptera: Lygaeidae) *Blissus insularis*, a serious pest of St. Augustine grass *Stenotaphrum secundatum*, in Florida. Journal of Economic Entomology 75:716-718.

The southern chinch bug first developed resistance to the insecticide DDT in 1957. Parathion was ineffective in 1961. By 1976, the chinch bug had developed resistance to two other organophosphate compounds, diazinon and chlorpyrifos. Alternate control substances, such as carbamates and synthetic pyrethroids, were tested. Propoxur—a carbamate insecticide—and two synthetic pyrethroids, namely permethrin and fenvalerate, provided satisfactory control of the chinch bug. Chlorpyrifos and isofenphos failed.

Reinert, J.A. 1982. Insecticide resistance in epigeal insect pests of turfgrass. I.A review. *In* H.D. Niemczyk and B.G. Joyner, eds., Advances in Turfgrass Entomology, pp. 71-76. Hammer Graphics, Piqua, OH.

Insecticide resistance in many common turfgrass insects is described. The insects included are webworms, bluegrass billbugs, greenbugs, hairy chinch bugs, and southern chinch bugs.

Reinert, J.A. 1982. A review of host resistance in turfgrasses to insects and acarines with emphasis on the southern chinch bug. *In* H.D. Niemczyk and B.G. Joyner, eds., Advances in Turfgrass Entomology, pp. 3-12. Hammer Graphics, Piqua, OH.

Resistance to insects is a desirable character in turfgrasses, but unfortunately, most turfgrasses lack this quality. The author reviews plant resistance in turfgrasses to insects such as fall armyworm, sod webworms, bluegrass billbug, mole crickets, twolined spittlebug, rhodesgrass mealybug, bermudagrass scale, the hairy chinch bug, and the southern chinch bug. The lack of many resistant turfgrass varieties is attributed to the lack of adequate techniques to screen turfgrass germplasm.

Reinert, J.A., B.D. Bruton, and R.W. Toler. 1980. Resistance of St. Augustinegrass to southern chinch bug and St. Augustine decline strain of Panicum mosaic virus. Journal of Economic Entomology 73:602-604.

Accessions of St. Augustine grass were selected for vigor, density, cold hardiness, and low maintenance in a breeding program. These selections were studied to see if they were also resistant to the southern chinch bug and the St. Augustine decline strain of Panicum mosaic virus. The accessions used in the study were FA-108, FA-2002, TX-33, Raleigh, Seville, Floratam, and Florida Common. These were artificially inoculated with the virus, and resistance ratings were made 21 days after treatment. Raleigh and Seville were compared with Floratam and Florida Common with respect to insect feeding. FA-108, FA-2002, TX-33, Raleigh, and Seville were resistant to the virus. FA-108 and TX-33 were resistant to the chinch bug. Combined resistance was found in Floratam, FA-108, and TX-33. The origin of combined resistance is discussed.

Reinert, J.A., P. Busey, and F.G. Bilz. 1986. Old world St. Augustine grasses resistant to the southern chinch bug (Heteroptera: Lygaeidae). Journal of Economic Entomology 79:1073-1075.

The southern chinch bug *Blissus insularis* Barber is a very destructive pest of St. Augustine grass. A study was conducted to identify chinch-bug-resistant clones of St. Augustine grass introduced from South Africa, Tanzania, Zimbabwe, and Malagasy. Thirty-four of these clones were studied using Floratam as the resistant check and Florida Common as the susceptible check. Chinch bugs were confined on grass stolon terminals and observations of mortality were recorded daily for 7 days. After 7 days, the total mortality and egg deposition were recorded. St. Augustine grass clones that exhibited antibiosis were polyploids, but not all polyploid clones were resistant. Resistance was identified in Old World and New World clones.

Reinert, J.A., and A.E. Dudeck. 1974. Southern chinch bug resistance in St. Augustine grass. Journal of Economic Entomology 67:275-277.

Experiments to identify resistant St. Augustine grass accessions were conducted in 1971 and 1972. Floratam, FA-108, and FA-118 exhibited adult and nymphal antibiosis. Floratine was found to be a tolerant variety.

Reinert, J.A., and S.H. Kerr. 1973. Bionomics and control of lawn chinch bugs. Bulletin of the Entomological Society of America 19:91-92.

Studies on the bionomics of the lawn chinch bug *Blissus insularis* have provided some interesting results. In northern Florida the insect has a third and a partial fourth generation. In southern Florida the pest has 6-7 generations a year. As temperatures start falling in winter, the population decreases. Damage to grasses in winter is minimal. The winter population consists entirely of adults. There is an increase in the population starting in February in southern Florida and in April in northern Florida.

Also provided are other minor details on the chinch bug bionomics in Florida. The natural enemies *Eumicrosoma benefica, Beauveria bassiana,* and nine other predators have been reported from this State. Insecticides such as Akton, carbophenothion, chlorpyrifos, diazinon, ethion, propoxur, and propyl thiopyrophosphate provide effective control of the pest. Notes on the hairy chinch bug are included.

Reinert, J.A., and H.D. Niemczyk. 1978. Resistance to organophosphate and chlorinated cyclodiene insecticides by the southern chinch. University of Florida IFAS, 10 pp.

The southern chinch bug developed resistance to DDT in 1957 and to some organophosphates (especially parathion) in 1961. By 1978, many more insecticides had joined the rapidly growing list of chemicals to which the bug was resistant. This paper reports the development of resistance to chlorpyrifos, diazinon, and chlordane.

Reinert, J.A., and H.D. Niemczyk. 1982. Insecticide resistance in epigeal insect pests of turfgrass. II. Southern chinch bug resistance to organophosphates in Florida. *In* H.D. Niemczyk and B.G. Joyner, eds., Advances in Turfgrass Entomology, pp. 77-80. Hammer Graphics, Piqua, OH.

The southern chinch bug first developed resistance to the insecticide DDT in 1957. Resistance in *Blissus leucopterus leucopterus* (Say) and *B. pulchellus* to cyclodienes has already been reported. To ascertain if the poor control obtained by chemicals was indeed because of resistance in the insect, the authors initiated field and laboratory studies. One cyclodiene compound, two carbamates, and six organophos-

phates were used to obtain information on field resistance and cross resistance. Pyrethroids were included as standards in one test. Chlorpyrifos was ineffective even when used at twice the normal recommended dosage. The carbamate insecticide propoxur provided satisfactory control. In laboratory tests, carbamates performed better than the cyclodienes and the organophosphates did.

Reinert, J.A., and K.M. Portier. 1983. Distribution and characterization of organophosphate resistant southern chinch bugs (Heteroptera: Lygaeidae) in Florida. Journal of Economic Entomology 76:1187-1190.

This paper embodies 3 yr of observations from research conducted with the southern chinch bug to determine the level of resistance to chlorpyrifos, an organophosphate insecticide. St. Augustine grass stolons were dipped in various concentrations of chlorpyrifos, and field-collected chinch bug adults were then released on them. Probit analysis was performed based on mortality 24 hr posttreatment and LC_{50}'s were calculated. These calculations confirmed that the insects have indeed developed high levels of resistance to the insecticides. Use of propoxur, a carbamate insecticide, is recommended to attain increased levels of control.

Reinert, J.A., R.W. Toler, B.D. Bruton, and P. Busey. 1981. Retention of resistance by mutants of 'Floratam' St. Augustine grass to the southern chinch bug *Blissus insularis* and St. Augustine decline strain of Panicum mosaic virus, insect and disease resistances. Crop Science 21:464-466.

Floratam is a cultivar of St. Augustine grass that has a good level of resistance to the southern chinch bug. Floratam was gamma irradiated and 13 mutants were obtained, which were tested for stability of resistance to the insect and the Panicum mosaic virus. Mutants were artificially inoculated with the virus, and damage ratings were made 21 days after the first symptoms were observed. Field-collected chinch bug adults were used for insect resistance studies. All the mutants retained resistance to the virus. Most of the mutants exhibited high levels of antibiosis to the chinch bug.

Richardson, C.H., C.C. Deonier, and W.A. Simanton. 1937. The toxicity of certain insecticides to the chinch bug. Journal of Agricultural Research 54:59-78.

An investigation was undertaken to examine the insecticidal efficiency of new compounds against the chinch bug. Laboratory and field studies were conducted. Sodium oleate, sodium-based laundry

soap, pure potassium oleate, commercial potassium oleate, commercial pot fish-oil soap, nicotine, piperidine, pyrethrum extract, rotenone, and derris extracts were applied as sprays on various stages of the insect. In the field, calcium cyanide, sodium fluoride, nicotine-bentonite mixture, anabasine-bentonite mixture, and powdered derris root were applied as dusts. The laundry soap was the most toxic of the soaps tested. Nicotine was more toxic to the adults than to the younger stages. Pyrethrum in acetone was also toxic. In the field, calcium cyanide was efficient only when the amounts applied were large enough to be phytotoxic.

Riley, C.V. 1870. The chinch bug *Micropus leucopterus* Say. Noxious and Beneficial Insects Report of Missouri 2:15-37.

The author gives an exhaustive account of the chinch bug, detailing its history in Missouri as an injurious pest, its habits, and the nature of its damage.

Roberts, R.J. 1963. Availability of dieldrin to adult *Blissus leucopterus* and larval *Cyclocephala immaculata* in treated sand, loam, and muck soils. Journal of Economic Entomology 56:781-785.

Soils with high clay or organic content bind most insecticides and make them unavailable to insects placed in contact with the soil. A study was undertaken to determine the relationship between an insecticide and soil, with particular reference to soils having marked quantitative differences in organic content. The effect of soil moisture on insecticidal action was also investigated. A soil ingestor, *Cyclocephala immaculata* (Olivier), and a nonsoil ingestor, *Blissus leucopterus leucopterus* (Say), were used in this study. Based on LC_{50} values, each test insect required a much higher concentration of dieldrin on muck or loam soils than on sand to obtain comparable mortalities. *Cyclocephala's* ingestion of dieldrin in muck soil did not greatly increase the biological availability of the large amounts of sorbed dieldrin. Contact tests with treated loam soils indicated a hyperbolic relationship between soil moisture and the effectiveness of dieldrin treatments against the chinch bug.

Schread, J.C. 1963. The chinch bug and its control. Connecticut Agricultural Experiment Station Circular 223, 4 pp.

The hairy chinch bug causes damage to lawns by sucking the sap from grass stems. More chinch bugs are found in the periphery of a damaged lawn than at the center. This circular discusses the biology of the chinch bug and its control. Experiments with insecticides for

chinch bug control were conducted in 1962. Pretreatment counts were taken from sample areas. Lawns were treated with 10 percent granular formulations of Sevin and ethion and a 3 percent dust formulation of diazinon. All three materials gave good control.

Schread, J.C. 1970. Chinch bug control. Connecticut Agricultural Experiment Station Circular 233, 6 pp.

By January 1970, diazinon, ethion, chlordane, Sevin, Akton, Aspon, Trithion, Dursban, and Baygon were registered in Connecticut for the control of hairy chinch bugs. This was the result of extensive studies conducted from 1964 through 1969 with various insecticides and formulations. In 1963, Sevin was reported to give good control, but by 1965 it had lost its efficacy, indicating the bug had possibly developed resistance. Bandane, Banol, and Trithion were tested in 1964, Dursban in 1965, Baygon and Akton in 1966, Dylox in 1967, and Akton, Miloganite, and Aspon in 1969. Bandane and Dylox were not registered for chinch bug control as of January 1970.

Sears, M.K., F.L. McEwen, G. Ritcey, and R.R. McGraw. 1981. Evaluation of insecticides for the control of the hairy chinch bug *Blissus leucopterus hirtus* (Hemiptera: Lygaeidae) in Ontario lawns. Proceedings of the Entomological Society of Ontario 111:13-20.

A number of insecticides were tested in 1973-77 for control of *Blissus leucopterus hirtus* Montandan in lawns in Ontario. Chlorpyrifos and isazophos (CGA-12223) at 1-2 kg/ha and diazinon at 2-4 kg/ha provided the most consistent control. Treatments early in the season when most of the lygaeids were in the third instar gave better control than those applied later did.

Severin, H.C. 1923. The chinch bug. Bulletin of the Agricultural Experiment Station South Dakota 202:561-576.

The chinch bug *Blissus leucopterus leucopterus* (Say) is not a destructive pest in South Dakota. In the 14 yr prior to 1923, the chinch bug had been troublesome only in 2 yr, 1921 and 1922. This bulletin describes the life history of the chinch bug in South Dakota, which is not different from the insects' life history elsewhere. In this State, chinch bugs have been harmful to wheat, barley, rye, corn, and sorghum. Chinch bug control by burning, growing immune and tolerant crops, and destroying the bugs through the aid of trap crops is suggested.

Shelford, V.E., and W.P. Flint. 1943. Populations of the chinch bug in the upper Mississippi valley from 1823 to 1940. Ecology 24:435-455.

The chinch bug *Blissus leucopterus leucopterus* (Say) was first recorded in North Carolina in 1783. Agriculture in the Mississippi Basin began around 1820, and there have been repeated outbreaks of this pest since then. The chinch bugs' damage is restricted to plants belonging to the family Gramineae. It has been calculated that an average of 400 bugs/m^2 can cause severe damage to small grains. A maximum of 17,000 bugs has been found on one hill of corn (per m^2). The populations vary in midsummer from very few to over 70 million/acre. Population density is dependent on weather parameters, such as rainfall and temperature.

This study demonstrated that to make proper correlations between weather parameters and chinch bug outbreaks, observation stations should be located close to one another. The record number of chinch bug outbreaks from 1820 to 1940 indicated a correlation with the number of sunspots. An even closer correlation was found between ultraviolet light intensity and bug population. It was also observed that when rainfall was above average, the chinch bug population during the spring was low.

Shimer, H. 1867. Notes on *Micropus* (*Lygarus*) *leucopterus* Say. (The chinch bug) with an account of the great epidemic disease of 1865 among insects. Proceedings of the Philadelphia Academy of Science 19:75-80.

The author closely followed the life history of the chinch bug in Illinois, and this paper includes his observation notes from March 7, 1865 to September 13, 1865. During this period, two insect predators, namely, *Hippodamia maculata* and *Chrysopa illinoiensis*, were found to be associated with the chinch bug. It was in 1865 that the fungus *Sporotrichium globuliferum* took an epidemic form and killed hordes of chinch bugs. This disease was associated with the wet, cloudy, and cool weather that prevailed during a large part of the bugs' development. The striped cucumber bug also was infected by the pathogen.

Short, D. 1972. Chinch bugs in lawns. Circular of the Florida Cooperative Extension Service 368, 8 pp.

A brief account of the presence and distribution of the chinch bug *Blissus insularis* in lawns is presented.

Short, D.E., and P.G. Koehler. 1979. A sampling technique for mole crickets and other pests in turf grass and pasture. The Florida Entomologist 62:282-283.

There are many insects apart from chinch bugs that infest lawns. Infestations of mole crickets are sporadic and unpredictable. Other insects observed in a lawn are army larvae, sod webworms, earwigs, and crickets. Studies on techniques to survey for field arthropods were conducted in 1978. Pyrethrins, Ivory dishwashing soap, apple cider vinegar, Lysol, and Parson's Sudsy Ammonia were used. Pyrethrins were the most effective, flushing an average of 11.46 mole crickets/0.6 m^2. Dishwashing soap flushed about 30 percent fewer mole crickets. The soap mixture, when used on St. Augustine grass, flushed chinch bugs and big-eyed bugs out to the grass surface.

Slater, J.A. 1976. Monocots (Monocotyledonae) and chinch bugs: a study of host plant relationships in the Lygaeid subfamily Blissinae (Hemiptera: Lygaeidae). Biotropica 8:143-165.

Members of the Lygaeid subfamily Blissinae are associated with a limited and related group of plants. This is evidence that a long evolutionary history exists between the insect and the Monocotyledanae hosts' group. Members of Blissinae are seen only on monocots belonging to the following families: Gramineae, Cyperaceae, Restionaceae, Zingiberaceae, Juncaceae, Sparganiaceae, Typhaceae, and Haemadoraceae. The most suitable hosts belong to the grass family Gramineae. Within the Gramineae family, species belonging to the tropical tribes Panicoideae and Eragrostoideae are more utilized by the bugs than others. Morphological modification of the Blissine species are discussed. Included are graphs representing grass-insect relationships and 12 plates showing morphological modifications of the Blissines.

Slater, J.A. 1979. The systematics, phylogeny, and zoogeography of the Blissinae of the world (Hemiptera: Lygaeidae). Bulletin of the American Museum of Natural History 165:1-180.

A historical review of the Blissinae is given and includes a summary of the biology and feeding habits of the members. A long list of species worldwide is furnished. The distribution of the various taxa is discussed.

Slater, J.A., and P.D. Ashlock. 1976. The phylogenetic position of *Praetoblissus slater* with the description of two new species (Hemiptera: Lygaeidae). Journal of the Kansas Entomological Society 49:567-579.

The genera *Praetoblissus Slater* and *Heteroblissus* Barber are both

South American. During preliminary cladistic studies, it was difficult to place these two genera. The phylogenetic position of these two primitive Blissine genera, is analyzed along with *Blissus, Capodemus, Caveloblissus, Dimorphopterus, Geoblissus, Ishnodemus, Macchiademus, Praeblissus,* and *Talpoblissus*. Two new species of *Praetoblissus,* namely, *P. wilcoxi* and *P. obrieni,* are described.

Slater, J.A., and M.H. Sweet. 1972. *Capodemus*: a new genus of Blissinae from South Africa with the description of 12 new species (Hemiptera: Lygaeidae). Journal of the Entomological Society of South Africa 35:211-234.

When on a collection trip to South Africa in 1967-68, the authors found that the taxon known as *Blissus rusticus* Stal. was actually a complex comprising closely related but distinct species. These species share a number of characters and represent a distinct genus. So, a new genus *Capodemus* was erected from the type species *Blissus rusticus.* Fourteen new species, namely, *bispinosus, wilcoxae, stuckenbergi, variabilis, tenuatus, sabulosus, elegiae, herbosus, distinctus, pentameri, hirsutus, rusticoides, rostratus,* and *rusticus* were transferred to *Capodemus.*

Slater, J.A., and D.B. Wilcox. 1973. The chinch bugs or Blissinae of South Africa (Hemiptera: Lygaeidae). Entomological Society of South Africa Memoirs 12:135.

This paper includes all the species of Blissinae known from South Africa. The authors describe nine new species and two new genera. They present keys to the genera *Ishnodemus, Atrademus, Micaredemus, Macropes, Barademus, Blissiella, Dimorphopterus, Talpoblissus, Geoblissus, Maceliademus,* and *Capodemus.*

Smith, M.T., G. Wilde, and T. Mize. 1981. Chinch bug: damage and effects of host plant and photoperiod. Environmental Entomology 10:122-124.

The rate of development, longevity, and oviposition of the chinch bug on varieties of wheat and barley and hybrids of corn and sorghum were studied. The females laid more eggs on the sorghum hybrid NC-170 than on Newton wheat or DeKalb XL 454 corn. The percentage of egg hatch and the longevity of adults did not differ among hosts. The rate of development of nymphs to adults was faster on sorghum than on any other host plants tested. Feeding damage to sorghum by last-instar nymphs was much higher than feeding by other instars. Overwintering adults that were first allowed to feed for a wk before feeding on the test plants caused more

damage than overwintering adults that were allowed to feed on the test plants directly.

Experiments on the effect of photoperiod on the chinch bug illustrated for the first time that photoperiod induced diapause in *Blissus leucopterus leucopterus* (Say). Bugs confined to a photoperiod of 16 hr (photophase) actively fed and mated, whereas those subjected to an 8-hr photophase went into diapause. These studies demonstrated that sorghum can be used as a rearing medium under a 16:8 hr (light:dark) photoperiod.

Smith, R.C. 1932. Fungus and bacterial diseases in the control of grasshoppers and chinch bugs. Kansas State Board of Agriculture Biennial Report 28:44-61.

This report was intended to provide the public with reliable information on the use of fungus and bacterial diseases against grasshoppers and chinch bugs. The chinch bug pathogens described are (1) the common fungus *Beauveria globulifera*, (2) the gray fungus *Empusa aphidis*, and (3) the bacterial disease caused by *Micrococcus insectorum*. The fungal diseases develop and spread faster under high moisture and humidity. The season most favorable to the chinch bugs are always less favorable to the fungal pathogens. So, the use of fungal spores is restricted. The author suggests that use of a fungus be judiciously combined with the normal remedial measures to keep the chinch bug population under control.

Snelling, R.O. 1936. Third generation and method of migration of chinch bugs in southwestern Oklahoma. Journal of Economic Entomology 29:797-803.

In most parts of the country the chinch bug *Blissus leucopterus leucopterus* (Say) has only two generations a year. This important paper describes three full generations under field conditions in southwestern Oklahoma from 1930 to 1934. Numerous host plants of the chinch bug such as wheat, oats, barley, corn, sorghum, broomcorn, and johnsongrass are grown in such a way that they provide food for this insect throughout the entire growing season. The growing season in Oklahoma is very long. Many workers have reported chinch bug migration on foot, but this 5-yr study demonstrated that chinch bug migration out of overwintering quarters is by flight. The use of crop varieties resistant to the chinch bug is recommended.

Snelling, R.O., and R.G. Dahms. 1937. Resistant varieties of sorghum and corn in relation to chinch bug control in Oklahoma. Oklahoma Agricultural Experiment Station Bulletin, 22 pp.

The use of resistant varieties of corn and sorghum is considered one of the least expensive and the most effective methods of combating the chinch bug. Progress made in developing resistant varieties is discussed. The authors warn that even though promising results have been obtained with resistant varieties, it is impossible to develop a variety that is immune to the pest. Details on the resistance and susceptibility of some corn and sorghum varieties are presented.

Snelling, R.O., R.H. Painter, J.H. Parker, and W.M. Osborne. 1937. Resistance of sorghum to chinch bug. U.S. Department of Agriculture Technical Bulletin 585, 56 pp.

One of the most promising methods of controlling the common chinch bug is use of resistant varieties of sorghum suitable in regions that are frequently and heavily infested. Investigations to determine the reactions of sorghum varieties to chinch bug injury and the possibilities of developing resistant types of sorghum were undertaken in Kansas and Oklahoma. Milos and feteritas were susceptible, whereas most of the kafirs and sorgos were relatively resistant. The selection Red Amber sorgo × feterita showed a high degree of resistance. Lasley sorgo was more susceptible than Kansas Orange. Among the kafirs, Dawn was resistant, Meade Red was moderately susceptible, and Double Dwarf Red kafir was susceptible. Results suggested that resistance may be dominant or partially dominant in the crosses studied. Resistance was found to be an inheritable character.

Snow, F.H. 1893. Chinch bugs: experiments in 1892 for their destruction by diseases. Kansas State Board of Agriculture Biennial Report 8:248-255.

This is an illustrated report presenting the results of growing the chinch bug pathogen *Sporotrichium globuliferum* and distributing it to farmers during 1892. About 1,400 packages were sent out, and the reports received indicated that 76.5 percent were successful, 13.0 percent were unsuccessful, and 10.5 percent were doubtful.

Snow, F.H. 1895. Contagious diseases of the chinch bug. University of Kansas Experiment Station Annual Report 4, 247 pp.

The results of field tests using the fungus *Sporotrichium globuliferum* are reported for 1894. The percentage of successful trials was only slightly greater than the percentage of unsuccessful trials. In Kansas, 875 farmers reported success, whereas 741 reported failure. The reports obtained from other states give 196 successes and 185 failures.

Spike, B.P., R.J. Wright, and S.D. Danielson. 1991. Chinch bug outlook. NebFact, University of Nebraska Cooperative Extension Division, 2 pp.

It was estimated that a total loss of $11.3 million in 1989 and $10.0 million in 1990 from chinch bugs was incurred by farmers growing sorghum in southeast Nebraska. Responses to questionnaires sent to sorghum farmers indicated that 79 percent had chinch bug problems. Chinch bugs prefer thin stands of wheat over normal or thick stands, and planting corn or sorghum adjacent to thin stands of wheat is discouraged. Planting of nonhost plants such as soybeans, sunflowers, and alfalfa in harvested wheat fields is suggested.

Spike, B.P., R.J. Wright, S.D. Danielson, and D.W. Stanley-Samuelson. 1991. The fatty acid compositions of phospholipids and triacylglycerols from two chinch bug species *Blissus leucopterus leucopterus* and *Blissus iowensis* (Insecta: Hemiptera: Lygaeidae) are similar to the characteristic dipteran pattern. Comparative Biochemistry and Physiology 998:799-802.

This is probably the first paper that analyzes the fatty acid profiles of the chinch bug. Despite short-term changes in fatty acid profiles, the majority of insect profiles are similar. It is not known whether the fatty acid profiles can be modified beyond the normal patterns seen in most insect representatives of a particular group. The fatty acid composition of nymphs and adults was analyzed. A high proportion of 16:1 acids was found in *Blissus leucopterus leucopterus* (Say). The overall profile was similar to that of *B. iowensis.* The fatty acid profiles of these two insect species were different from profiles of other insects, except some Dipterans. The proportion of polyunsaturated fatty acids was low in the insects tested.

Starks, K.J., A.J. Casady, O.G. Merkle, and A.D. Boozaya. 1982. Chinch bug resistance in pearl millet. Journal of Economic Entomology 75:337-339.

This is the first report of experiments conducted exclusively on pearl millet resistance to chinch bug. Two hundred entries were included in field and greenhouse studies of resistance and inheritance of resistance. Damage ratings were recorded 28-30 days after planting. It was found that 38 of the 200 entries from the experimental population MXPI (S) C_2 were resistant. Of the entries 60.5 percent had intermediate levels of resistance and 20.5 percent were susceptible. The number of chinch bugs on the resistant entries was fairly high, so the mechanism of resistance was probably tolerance. Based on

segregation patterns, it was theorized that the same gene for resistance was present in the resistant lines.

Starks, K.J., and D.E. Weiberl. 1982. Sorghum cultivars rated resistant to chinch bug *Blissus leucopterus*. Sorghum Newsletter 25:82-83.

Sixty sorghum cultivars were evaluated in the field for chinch bug resistance. The kafirs were the most resistant. The Sooner milos were not as susceptible as other milos were.

Streu, H.T. 1973. The turfgrass ecosystem: impact of pesticides. Bulletin of the Entomological Society of America 19:89-91.

The turfgrass ecosystem is very complex and includes a diverse array of organisms. It can be inhabited by chinch bugs, sod webworms, white grubs, other insects that cause economic damage, and nonpests, such as mites and nematodes. These organisms interact with the plants and thatch that make up the turfgrass ecosystem. Because of the wide range of pests capable of causing economic damage to turfgrasses, pesticides are frequently used. The impact of pesticides can be cumulative over a number of seasons, leading to pest resurgence, insecticide resistance, and secondary pest outbreak. This paper includes descriptions of some of the aforementioned effects. The author concludes that continued and heavy pesticide usage in turfgrass contributes to and aggravates thatch and pest problems.

Streu, H.T., and C. Cruz. 1972. Control of the hairy chinch bug in turfgrass in the northeast with Dursban insecticide. Down to Earth 28(1):1-4.

The hairy chinch bug causes damage to most of the common turfgrasses, including ryegrass, bluegrass, red fescue, and bentgrass. Because this pest developed resistance to some important organophosphate chemicals, it became necessary to evaluate new insecticides for their usefulness in turfgrasses. This study was conducted in turfs consisting of mixtures of Kentucky bluegrass and red fescue. Chlordane, diazinon, Dursban, and Phosvel were the insecticides tested. Even though Dursban was applied only once (compared to two applications of chlordane and diazinon), it gave very good control of the hairy chinch bug, successfully controlling the population for an entire season. The residual effects are reflected in low spring populations. One treatment of Dursban in mid-June was the most effective because it controlled the first- and second-instar nymphs of the first generation.

Stringfellow, T.L. 1969. Developments in Florida turfgrass insect control. Proceedings of Florida Turfgrass Management Conference 17:94-100.

Results of chinch bug control tests with insecticides are presented. Dasanit, Dyfonate, Furadan, Mocap, and Velsicol's VCs 506 were found to be very effective against the bugs.

Stringfellow, T.L. 1969. Turfgrass insect research in Florida. Proceedings of the Scotts Turfgrass Research Conference 1:19-29.

Information pertaining to research conducted on sod webworm, chinch bug, and scale insects is presented. Insecticides were evaluated for their effectiveness against the chinch bug. Comparison of initial knockdown, as well as residual activity, were made. The compound Monsanto CP 47114 provided immediate knockdown effects. Bromophos at 8 lb/acre gave satisfactory control of the pest.

Stuart, J., G. Wilde, and J.H. Hatchett. 1985. Chinch bug (Heteroptera: Lygaeidae) reproduction, development, and feeding preference on various wheat cultivars and genetic sources. Environmental Entomology 14:539-543.

A large number of wheat cultivars were evaluated for their effect on various biological parameters of the chinch bug *Blissus leucopterus leucopterus* (Say). The parameters studied were reproduction, female longevity, developmental rate, mortality of nymphs, and feeding preference of adults, among others. Except on a few lines, there were no differences in chinch bug reproduction and longevity. CI 15321 exhibited low levels of antibiosis. Even though there was 97 percent egg hatch on CI 15321, the rate of development of nymphs significantly decreased, and almost half the nymphs developed into smaller adults. There were no significant differences in the developmental periods among the lines tested. Preference studies indicated no differences in feeding among the various cultivars. Resistance found in the varieties was not sufficient to stop the buildup of high chinch bug populations on the test lines.

Swenk, M.H. 1925. The chinch bug and its control. Nebraska Agricultural Experiment Station Circular 28, 34 pp.

In 1871, there was a general outbreak of the common chinch bug in the central Mississippi Valley states, including parts of southeastern Nebraska. This outbreak reached its height in 1874 when the crop loss in Nebraska amounted to $750,000. In 1887, the problem was

aggravated and this time the loss stood at $4 million. The pest has spread all over the State since that time. This circular provides information on the feeding habits of the bug, its seasonal history, and its life stages. Chinch bug abundance is mainly controlled by weather conditions during its reproductive periods and by the efficiency of parasites, predators, and contagious diseases. The growing of immune, nonhost, and resistant crops is recommended to keep the population to a minimum. The construction of various kinds of barriers is also described.

Swenk, M.H., and D. Tate. 1941. Control of the chinch bug in Nebraska. Nebraska Agricultural Experiment Station Circular 61.

This is a revision of circular number 28, cited above.

Tate, H.D., and D.B. Gates. 1945. Toxicity of sabadilla to chinch bugs and squash bugs. Journal of Economic Entomology 38:391.

Toxicity of sabadilla to chinch bugs *Blissus leucopterus leucopterus* (Say) and squash bugs was evaluated in the field and laboratory. The immediate effect of this material on the bugs was hyperexcitation, followed by decreased activity and death. Field tests were performed on first-generation chinch bugs. Sabadilla dusts and sprays were applied directly on insects confined to grasses by a barrier of dinito-ortho-cresol. Close to 100 percent mortality was observed after 5 days. Laboratory tests were performed on second-generation bugs that were treated with various concentrations of sabadilla. A 10 percent dust formulation and a spray containing 2 lb of sabadilla/100 gal of water resulted in high levels of mortality. It was concluded that sabadilla can be used to protect valuable experimental material or seed crops from chinch bug infestation.

Tauber, O.E., A.H. Tauber, W.N. Bruce, and J.T. Griffiths. 1944. Effect on the chinch bug (*Blissus leucopterus* Say) of contact with various dinitrophenols and other dusts. Iowa State College Journal of Science 18:225-265.

During the war, the danger of a shortage of creosote for the construction of chinch bug barriers led researchers to investigate the potential of some of the dinitrophenol dusts for use against the chinch bug. Investigations began in 1942 in the laboratory, and all experiments were done with field-collected *Blissus leucopterus leucopterus* (Say). Contact toxicity of the dusts was tested by setting

up a 1-inch-wide circular dust barrier, 6 inches in diameter, on a smooth paper surface. The 4-inch circle inside was dust free. An equivalent of 65-75 lb of dust/acre was used. Bugs were released on the paper strips. When dinitro-o- cresol (DN-O-C) was diluted with sulfur, the mixture was more toxic than that of DN-O-C concentration with pyrax or Pyrophyllite as the diluent. DN-O-C in liquid form was more toxic than the dry form. Dinitro-o-secondary-butylphenol was the most toxic of the dusts tested. Ammonium dinitro-o-cresylate was also found to be extremely toxic to the chinch bug.

Thomas, C. 1879. The chinch bug: its history, characters and habits, and the means of destroying it or counteracting its injuries. The American Entomologist 3:240.

This paper is an extensive review of the chinch bug *Blissus leucopterus leucopterus* (Say) in Illinois. The relation of temperature and rainfall to chinch bug outbreaks is discussed. The author was able to show a constant relationship between temperature and infestation. Data relating to rainfall and outbreaks of the pest were collected from 1840 through 1877. When the mean temperature was below average and the amount of rainfall was above average, the chinch bugs were not destructive.

Thomas, P.A. 1969. Dursban insecticide for the professional pest control operator. Down to Earth 25(3):26-33.

This paper provides information on the use of Dursban to control pests such as American cockroaches, Australian cockroaches, brown cockroaches, brown-banded cockroaches, German cockroaches, carpet beetles, ants, earwigs, fleas, silverfish, spiders, ticks, chinch bugs, sod webworms, mole crickets, millipedes, southern armyworm, rhodesgrass scale, bermudagrass mite, soft scale, tea scale, mealybugs, whiteflies, aphids, and grasshoppers. Characteristics of Dursban, such as odor, knockdown effects, and formulation are discussed.

Walden, B.H. 1935. Notes on the hairy chinch bug—a pest of lawns. Connecticut Agricultural Experiment Station Bulletin 383:328-329.

The presence of the hairy chinch bug is detected by brownish spots that appear in sections of the lawn. As the insects grow in numbers, the size of these spots increases to cover much of the lawn. Lawns having mixtures of bentgrass or a predominance of bentgrass attracted more bugs. A brief description of the pest and its life history is provided. Chinch bugs are readily killed by contact insecticides, but it is necessary to thoroughly wet all of the bugs to get good control. A mixture of nicotine sulfate (1 qt), soap powder (4 lb), and

water (100 gal) at the rate of 25-30 gal/100 ft^2 gave satisfactory control.

Walsh, B.D., and C.V. Riley. 1869. The chinch bug. The American Entomologist 1:194-199.

This extended account of the chinch bug *Blissus leucopterus leucopterus* (Say) gives the experiences of western farmers with the pest, its life history, the effect of weather on its numbers, and different remedies.

Walton, R.R. 1945. Chinch bug dust barrier: preliminary tests. Journal of Economic Entomology 38:713-714.

Experiments were conducted to evaluate chemical dust barriers for their efficiency in curtailing chinch bug movement and, ultimately, their numbers. Creosote, dinito-ortho-cresol, sabadilla, and DDT were used as barrier materials. A modified field test was done to evaluate the effectiveness of insecticidal dust barriers 1-4 days after construction. A 10 percent dust of sabadilla was effective in stopping chinch bug movement in the modified test—15-25 percent of the bugs died without crossing the barrier. DDT continued to kill the bugs 6 days after construction of the barrier. The chemicals were also tested for their toxicity to turkeys. The insecticides produced no detrimental effects on the birds.

Watson, J.R., and H.E. Bratley. 1929. The chinch bug on St. Augustine grass. Florida Agricultural Experiment Station Bulletin 209:18-20.

The chinch bug has been a notorious pest of turfgrasses for a long time. It causes damage by desapping the plants and eventually leading to plant death. The bulletin describes methods of controlling this insect by (1) using finely ground tobacco as an insecticidal dust, (2) dusting with 3-percent nicotine sulfate-lime dust, (3) using a potent contact insecticide such as calcium cyanide, and (4) spraying solutions of nicotine sulfate on the bugs.

Webster, F.M. 1896. The chinch bug. Ohio Agricultural Experiment Station Bulletin 69:59-79.

The chinch bug *Blissus leucopterus leucopterus* (Say) is one of the most destructive pests in the United States and extends over most of the country east of the Rocky Mountains. The bug has two generations a year. This bulletin provides illustrative descriptions of the various life stages of this pest. The population buildup is phenomenal under very dry conditions. High rainfall and humidity are detrimental to

the insect. Control measures, such as spraying kerosene emulsion, plowing and harrowing the ground to bury large numbers of the insect, use of the fungal pathogen, and burning of trash and stubbles are recommended.

Webster, F.M. 1897. Three years' study of an outbreak of the chinch bug in Ohio: some destructive insects that should be watched in Ohio. Ohio Agricultural Experiment Station Bulletin 77:33-52.

The first outbreak of the common chinch bug in Ohio was in 1895. The summer of 1895 was very dry, and by the end of June, the populations had started swelling. The conditions in 1895 favored an outbreak in 1896. The fungus *Sporotrichium* was distributed to most localities in the State, but even a large application of 750 packages of the fungus was not sufficient to bring any relief to the farmers because of the extremely dry weather. The bulletin also provides an extended outlook for the year 1897. Maps of different sections of Ohio showing the distribution and spread of the bugs are included.

Webster, F.M. 1898. The chinch bug: its probable origin and diffusion, its habits and development, natural checks and remedial and preventive measures, with mention of the habits of an allied European species. U.S. Department of Agriculture, Division of Entomology, Bulletin 15, 82 pp.

This bulletin features a theory about the probable origin of the chinch bug. Webster theorized the chinch bug probably is of central American origin and they migrated northward. The migration divided into three lines, with one following the eastern coast to the Maritime Provinces of Canada and the second following the Pacific Coast, but not being as strong a movement as that along the East Coast. The third followed the Mississippi Valley. Bugs from this migration apparently encountered conditions that were favorable because in this region the insect became the most abundant and destructive.

Webster, F.M. 1899. The chinch bug: experiments with insecticides. Ohio Agricultural Experiment Station Bulletin 106:237-256.

Details and results of experiments with a number of insecticides are presented. Kainit, tobacco, whale oil soap, tobacco decoction, and carbon bisulfide were tested. Most of the information presented in bulletin number 69 (listed following) is also presented here. Details on the history, biology, and distribution of the chinch bug are presented. The author's theory for the probable cause of diffusion of the chinch bug is also presented.

Webster, F.M. 1907. The chinch bug. U.S. Department of Agriculture, Bureau of Entomology, Bulletin 69, 95 pp.

An account of chinch bug history, life stages, food plants, seasonal biology, and remedies is presented.

Webster, F.M. 1909. The chinch bug (*Blissus leucopterus* Say). U.S. Department of Agriculture, Bureau of Entomology, Circular 113, 27 pp.

This publication is a revision of the aforementioned bulletin.

Webster, F.M. 1915. The chinch bug. U.S. Department of Agriculture Farmers Bulletin 657, 28 pp.

This bulletin deals with a description of various stages of the chinch bug *Blissus leucopterus leucopterus* (Say), its seasonal history, hibernation, damages, natural enemies, and effect of weather conditions on its abundance. Control measures described include destruction of chinch bugs during hibernation, growing trap crops or decoy plants, and construction of barriers. The importance of being watchful during protracted periods of drought is emphasized.

Webster, J.E., and V.G. Heller. 1942. The chemical composition of Atlas and Dwarf Yellow milo plants in relation to chinch bug resistance. Oklahoma Agricultural Experiment Station Technical Bulletin 12, 29 pp.

Two varieties of sorghum viz—Atlas, a tall-growing resistant variety, and Dwarf Yellow milo, a short type with high susceptibility to the chinch bug—were analyzed for differences in biochemical composition. The goal of this study was to relate resistance to some biochemical characteristic of the sorghum plant. Solids, ash, minerals, pH, astringency, sugars, nitrogen, hydrocyanic acid, conductivity, and enzymes were estimated. Milo had higher solids content, but there were no significant differences in the solids content. Milo also had higher ash content. The amount of tannins was highest in younger plants, and tannin content varied greatly from yr to yr. Nitrogen content in Atlas decreased with plant growth. In milo, the reverse was the case. The HCN content in both varieties appeared to be identical. Sugars progressively increased with age in both varieties. Milo had more total sugars than Atlas, and the differences seemed more noteworthy than any other found in this study. Enzyme analyses were inconclusive.

Webster, J.E., and H. Mitchell. 1940. Determination of the nitrogen fractions in Atlas and milo sorghum plants. Plant Physiology 15:749-753.

The addition of nitrogenous fertilizers to sorghum plants increases their susceptibility to the chinch bug *Blissus leucopterus leucopterus* (Say). It has been shown that susceptible varieties have higher levels of nitrogen than do resistant varieties. A study was undertaken to determine the relative concentrations of various fractions of nitrogen in Atlas and milo plants. The fractions determined were cyanogenetic N, soluble N, ammonia N, amide N, humin N, basic N, amino N, nitrate N, and total N.

Percentage of cyanide, ammonia, humin, and nitrate N varied to a small extent at specific dates. The total amounts of these fractions were relatively low and showed the same general trend in both varieties. The soluble N content of milo increased as the plants aged, whereas in Atlas this fraction fluctuated and reached the lowest point during the last sampling (old plants). Atlas plants had more amide N. Amino N percentages showed the greatest varietal differences. This fraction, combined with the basic fraction, contributed to the higher percentage of soluble N in milo plants.

Webster, J.E., J.B. Sieglinger, and F.F. Davies. 1948. Chemical composition of sorghum plants at various stages of growth and relation of composition to chinch bug injury. Oklahoma Agricultural Experiment Station Technical Bulletin 30, 32 pp.

Many varieties of sorgo, kafir, feterita, and milo were analyzed for changes in biochemical characteristics with plant growth. An attempt was made to correlate chemical composition of plants with injury from the chinch bug *Blissus leucopterus leucopterus* (Say). The amounts of tannins, HCN, and sugars were not important factors in resistance. Bleeding did not seem to be a factor in resistance because several of the highly susceptible varieties bled more exudates than the resistant varieties. This study provided no overall chemical differences that could be correlated with chinch bug resistance. Root exudates also failed to show any differences among varieties.

Webster, J.E., J.B. Sieglinger, and F.F. Davies. 1954. The chemical composition of sorghum roots and its relation to chinch bug injury. Oklahoma Agricultural Experiment Station Technical Bulletin 49, 9 pp.

Several varieties of sorghum at various stages of growth were tested for differences in the chemical composition of roots. The writers made an effort to relate chemical differences, if any, to chinch bug

injury. Amounts of solids, ash, nitrogen, and sugars were estimated. In all four varieties tested, nitrogen content decreased with plant age. The chemical composition of roots showed no significant differences among the varieties during the stages studied.

Webster, J.E., and R. Wall. 1942. Electrical conductivities of sorghum juices in relation to chinch bug injury. Proceedings of the Oklahoma Academy of Science 22:35-37.

Juices from two sorghum varieties were extracted using a Carver laboratory press. The ash values and specific conductivities of the juices were measured. Analysis of the conductivity data suggested there was no correlation between resistance to chinch bug injury and conductivity of the juice. The specific conductivity is not a factor in explaining varietal differences in chinch bug resistance.

Weed, C.M. 1888. Experiments in preventing curculio injury in cherries, the chinch bug in Ohio: midsummer remedies. Ohio Agricultural Experiment Station Bulletin 4:39-55.

This bulletin presents chinch bug control measures in a condensed form for Ohio farmers. The remedies suggested are (1) plowing infested wheat fields immediately after harvest because the bugs find it difficult to crawl over dry, pulverized soil, (2) burning stubble in infested fields, (3) constructing coal-tar barriers to stop migration, (4) spraying kerosene emulsion on bugs, and (5) constructing furrows that are friable and dusty to prevent the bugs from getting past.

Wheeler, A.G., and J.E. Fetter. 1989. *Blissus breviusculus*: new distribution records of a little known chinch bug (Heteroptera: Lygaeidae). Journal of the New York Entomological Society 97:265-270.

A univoltine chinch bug that is similar to *Blissus iowensis* is described. *Blissus breviusculus* Barber is associated with little bluestem. This chinch bug is found in Maine, Massachusetts, Connecticut, and northeastern Pennsylvania. This new chinch bug is described in detail and compared with *B. iowensis*.

Whittington, F.B., and L.L. Luber. 1936. Study of chinch bug populations in Ohio. Journal of Economic Entomology 29:684-686.

Because large numbers of chinch bugs developed in 1934 from favorable ecological factors, a study was undertaken to determine the possibility of a serious outbreak in the spring 1935. Analysis of

plant samples showed a large number of bugs had gone into hibernation. Volunteer timothy grass was used as the sampling medium. Observations on the number of chinch bugs and the abundance of volunteer timothy grass were made. Chinch bug numbers were highest in the north-central part of Ohio and decreased in all directions from the center.

Wilde, G. 1979. Chinch bug *Blissus leucopterus* resistance in grain sorghums: breeding resistant varieties. Proceedings of the 34th Annual Sorghum Research Conference, pp. 188-192.

Foliar insecticides do not always provide economic control because chinch bugs feed under leaf sheaths. This paper reviews a series of trials done in Kansas to screen sorghum varieties for chinch bug resistance. Lines from a sorghum conversion program were studied. Tall and grassy selections were less damaged than others. The writer also evaluated five hybrids for resistance to the chinch bug. Yield reductions ranged from 12 percent in hybrids rated as resistant to 67 percent in hybrids rated as susceptible. When resistant inbred lines were compared with the hybrids, greater stand reductions in the inbreds were found, demonstrating that hybrid vigor can contribute to resistance.

Wilde, G., A. Kadoum, and T.W. Mize. 1984. Absence of synergism with insecticide combinations used on chinch bugs (Heteroptera: Lygaeidae) (*Blissus leucopterus leucopterus*). Journal of Economic Entomology 77:1297-1298.

Insecticides have been used for a long time to control the chinch bug. An account is given of experiments performed with combinations of insecticides to determine possible synergistic effects against the pest. Cypermethrin (97 percent) was mixed with chlorpyrifos (99 percent), carbofuran (97 percent), and carbosulfan (98 percent), and the effects of these mixtures were studied. LD_{50} and LD_{95} were estimated based on five doses of the insecticides. Tests were performed using a mixture of cypermethrin and the synergist piperonyl butoxide. Bugs were released into petri dishes whose insides were coated with the test materials. Mortality was recorded 48 hr after the treatment. Carbofuran was the most toxic, followed by cypermethrin, chlorpyrifos, and carbosulfan, in that order. There was no evidence of synergism in the mixtures tested.

Wilde, G., and T.W. Mize. 1984. Enhanced microbial degradation of systemic pesticides in soil and its effect on chinch bug *Blissus leucopterus leucopterus* (Say) and greenbug *Schizaphis graminum (Rondani)* control in seedling sorghum. Environmental Entomology 13:1079-1082.

Soil from fields with a history of carbofuran application and from those where no carbofuran had been previously applied were used in studies of microbial degradation of the pesticide and its effect on chinch bugs and greenbugs. In the greenhouse, carbofuran and five other insecticides were used in degradation studies. Soils were heat sterilized in one of the experiments and compared with unsterilized soil to determine the effect of sterilization on degradation of insecticides. There was enhanced degradation of chemicals in soils with a history of carbofuran application as evidenced by reduced chinch bug and greenbug control. Microbes quickly degraded Lance and Oncol in soils with a history of application, but aldicarb, phorate, and terbufos persisted and exerted good control of the pests. Soil sterilization killed the microbes and no degradation was observed in these soils. These experiments have provided researchers with a bioassay tool for studies of this nature.

Wilde, G., T.W. Mize, and M. Meehan. 1989. Rearing and screening methodologies for the chinch bug *Blissus leucopterus leucopterus. In* International Symposium on Methodologies for Developing Host Plant Resistance to Maize Insects, March 9-14, 1987, pp. 67-73. International Maize and Wheat Improvement Center (CIMMYT), El Batan, Mexico.

Methods are described for evaluating maize germplasm for chinch bug resistance, for studying components of resistance, and for rearing chinch bugs in the greenhouse. Field and greenhouse screening methods are explained in detail. Tests for tolerance, antibiosis, and antixenosis are described.

Wilde, G., T.W. Mize, J. Stuart, J. Whitworth, and R. Kinsinger. 1984. Comparison of planting time applications of granular or liquid insecticides and liquid fertilizer plus insecticide combinations for control of chinch bugs (Heteroptera: Lygaeidae) and greenbugs (Homoptera: Aphididae) on seedling sorghum. Journal of Economic Entomology 77:706-708.

This paper embodies observations of a 3-yr study on comparisons of granular and liquid insecticides and starter-fertilizer combinations for control of chinch bugs and greenbugs. Various formulations of carbofuran and carbosulfan were used with liquid fertilizers. "Liquid insecticides applied in the furrows at planting time, in combination with liquid fertilizer provided as good or better protection of sorghum plants from chinch bugs and greenbugs than granular or liquid insecticides applied by themselves at comparable rates." The writers suggest that fertilization combined with pest control could be beneficial in certain crop and pest situations.

Wilde, G., and J. Morgan. 1978. Chinch bug *Blissus leucopterus leucopterus* on sorghum: chemical control, economic injury levels, plant resistance. Journal of Economic Entomology 71:908-910.

Newly registered insecticides were evaluated for their effectiveness in controlling the chinch bug. Both foliar and granular insecticides were tested in the field. Disulfoton and all granular insecticides were also tested in the growth chamber. Sprays of ethyl parathion, carbaryl, carbofuran, and Penncap M proved to be very effective in reducing chinch bug numbers. Carbofuran and phorate granules applied at planting time were not effective in the field but produced very good results in the growth chamber. Investigations of the economic injury levels found that a total of 30 bugs per plant could kill a 100-mm seedling in 7 days. Fewer bugs caused severe stunting. Damage depended on the stage of plant growth. In field tests, a total of 1,700 bugs per plant at the blooming stage drastically reduced yields. Studies on plant resistance indicated that the variety Early Sumac was more resistant than Honey, Redlan, and Spanish Broomcorn.

Wilde, G., and J. Morgan. 1978. Control of chinch bugs on sorghum. Proceedings of the North Central Branch of the Entomological Society of America 33:26.

This paper, presented at the 33rd meeting of the North Central Branch of the Entomological Society of America, was published as a full-fledged paper later that yr. Details are presented in the next abstract.

Wilde, G., O. Russ, and T.W. Mize. 1986. Tillage, cropping, and insecticide use practice: effects on efficacy of planting time treatments for controlling greenbug (Homoptera: Aphididae) and chinch bug (Heteroptera: Lygaeidae) in seedling sorghum. Journal of Economic Entomology 79:1073-1075.

In-furrow treatment of carbofuran was applied at planting time under two different cropping patterns to obtain information on the efficacy of the insecticide under different environmental conditions. The cropping patterns studied were continuous sorghum and a sorghum-soybean rotation under three tillage practices—no till, conventional till, and reduced till. Chinch bug control was significantly better in the sorghum-soybean rotation. These tests indicated no significant differences in insecticidal efficacy among the different tillage systems studied.

Wilde, G., J. Stuart, and J.H. Hatchett. 1986. Chinch bug (Heteroptera: Lygaeidae) reproduction on selected small grains and genetic sources. Journal of the Kansas Entomological Society 59:550-551.

Sixteen vernalized wheat entries were evaluated for their resistance to the chinch bug. Some lines were already known to exhibit antibiosis to the pest. Susceptible checks were also included in the no-choice tests to screen varieties for antibiosis. Varieties showing antibiosis contained genetic material from the *Agropyron elongatum* genome. The entries CI 15321 and 15322 exhibited low levels of antibiosis.

Wilson, R.L., and R.L. Burton. 1980. Feeding and oviposition of selected insect pests on proso millet cultivars. Journal of Economic Entomology 73:817-819.

The chinch bug *Blissus leucopterus leucopterus* (Say) attacks many crops belonging to the family Gramineae. It is known to feed on the proso millet *Panicum miliaceum* L., but nothing is known about the reaction of this crop to insect injury. To obtain information on the relation of proso millet to insect injury, tests were conducted in Oklahoma. The insects studied were the fall armyworm, southwestern corn borer, corn earworm, chinch bug, and yellow sugarcane aphid. Ten cultivars were evaluated for their reaction to these pests. Akron was the most susceptible cultivar and Big Red was the most resistant cultivar in the first yr of study. Big Red was damaged during the second yr of study. This was the only cultivar that showed good tolerance to the chinch bug.

Worthington, A.D., and G.C. Decker. 1936. Fighting chinch bugs in Iowa. Journal of Economic Entomology 29:760-764.

The chinch bug population in Iowa started building up in 1932, and by 1934, control measures had to be implemented in 50 counties. County campaigns were organized to educate farmers about the various methods of control, including barrier construction demonstrations by the extension entomologist. All efforts were supplemented by radio talks, newspaper articles, and educational exhibits. The major categories of control used in Iowa in 1935 were crop planning and construction of barriers.

Wright, R.J., and S.D. Danielson. 1992. First report of the chinch bug (Heteroptera: Lygaeidae) egg parasitoid *Eumicrosoma beneficum* Gahan (Hymenoptera: Scelionidae) in Nebraska. Journal of the Kansas Entomological Society 65:346-348.

The authors reported the presence of the scelionid chinch bug egg parasitoid in Nebraska. Wheat plants were sampled in the field and brought to the laboratory, and chinch bug eggs were collected from the base of these plants. Eggs were kept on moist paper at 25 °C until wasps started emerging. The parasitoids were sexed based on antennal characters. Of the eggs collected, 47.2 percent were parasitized by *Eumicrosoma beneficum*. A subsample indicated that 64.1 percent of the wasps were females.

Yuasa, H. 1918. An extra molt in the nymphal stages of the chinch bug. Entomological News 29:233-234.

In 1875, Riley described only four nymphal stages of the chinch bug and this notion persisted. In 1916, the author conducted experiments on the chinch bug and observed five molts. It was thought that the extra molt occurred either between the first and second or the second and third molts described previously by Riley. The five instars were easily distinguished based on wing pad characters. All five instars were observed in the field.